The Infobahn: Highway to the Universe

ASTRONOMY®

Naked Quasars & Other News

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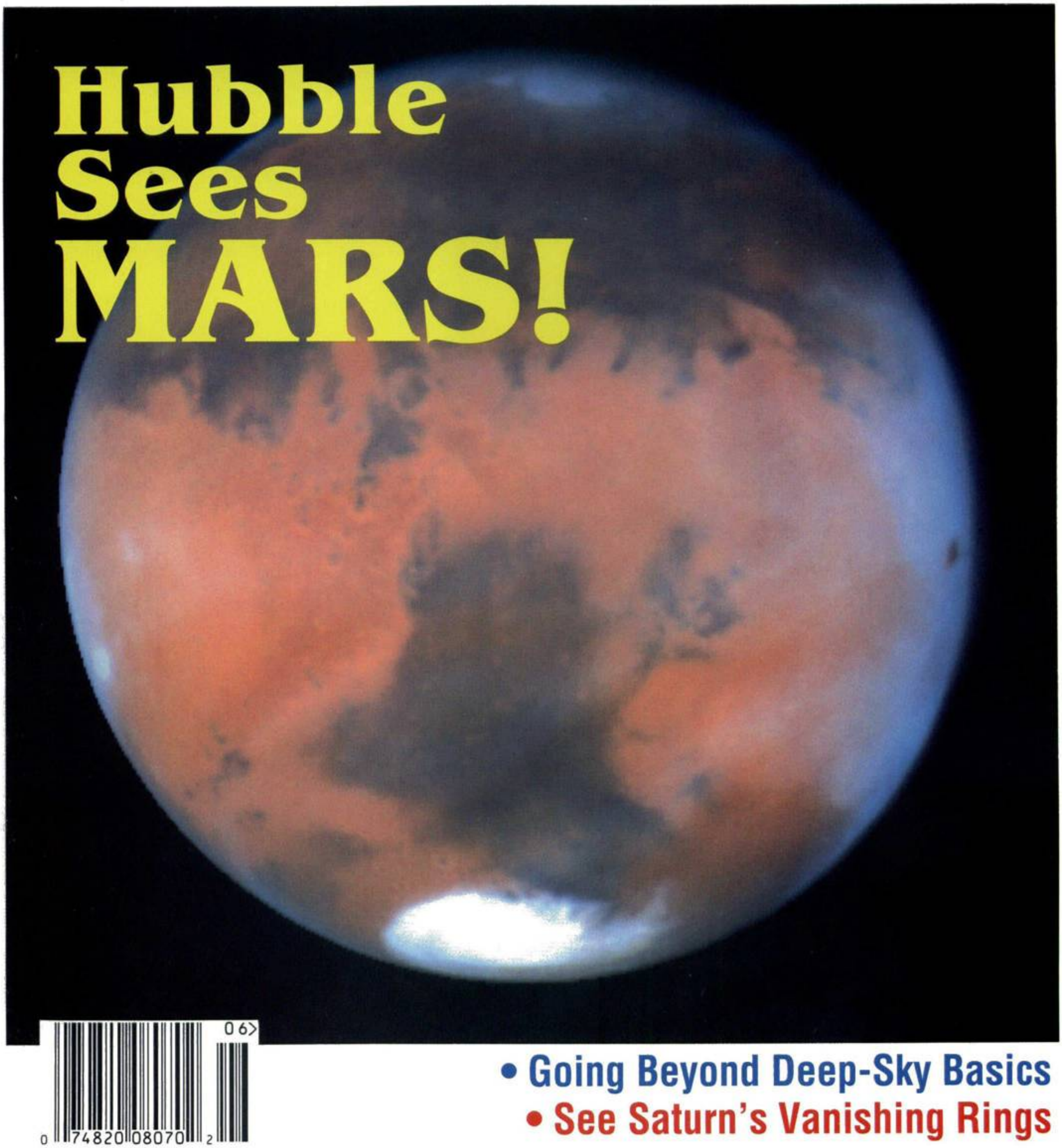

- Going Beyond Deep-Sky Basics
- See Saturn's Vanishing Rings

MEADE
12" LX200
10" LX200
8" LX200
MEADE LX200 EMC
MEADE LX200 EMC
MEADE LX200 EMC
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Supplied complete per catalog specifications**:

8" LX200 Schmidt-Cassegrain	**$2495.**
10" LX200 Schmidt-Cassegrain	**$2895.**
12" LX200 Schmidt-Cassegrain	**$3995.**

Packing & shipping in 48 states: 8"—$105; 10"—$145; 12"—$215.

- ■ **All prices shown are suggested USA mail-order retail prices, exclusive of sales taxes or credit card charges, if applicable.

- ■ For dealer or catalog information see the **Meade Starfinder Reflecting Telescope** ad in this issue.

Now with *one arc-minute* pointing accuracy and 64,350-object onboard database as *standard-equipment!*

Meade 8", 10", and 12" LX200 models with standard-equipment High-Precision Pointing™ software now automatically GO TO any input RA and Dec, or to any object in the 64,350-object database, to a pointing precision within one arc-minute!

New Meade Version 3.30 software and high-resolution encoders, used in conjunction with the unique Meade SYNC command, now yield the most precise automatic slewing ever offered in a commercial telescope, an observatory-level of precision and *more than 5 times the precision obtainable with any competing computer-controlled telescope.* Data entry through the telescope's keypad hand controller may be made either from the onboard 64,350-object library database *(see description at right)* or by inputting the desired object's RA and Dec.

Such precise object-acquisition, selectable during either altazimuth or equatorial operation of the LX200, has numerous important implications for the serious observer:

HIGH PRECISION POINTING

LX200's with High-Precision Pointing have a logo-plate affixed to the telescope's drive base.

All Meade LX200 models now include a 64,350-object onboard database as standard equipment.

Imagine having 64,350 celestial objects at the tip of your finger: 64,350 objects that you can center in the telescopic field just by entering and pressing GO TO on the hand controller. **More than 6 times the size of object libraries included with competing telescopes,** the Meade 64,350-object library includes an incredible array of phenomena—virtually a lifetime of deep-space study, even for the advanced observer:

12,921	galaxies from the Uppsala General Catalog; the complete UGC catalog.
7,840	objects from the New General Catalog; the complete NGC catalog.
5,386	objects from the Index Catalog; the complete IC catalog.
21,815	variable stars; the complete listing from the General Catalog of Variable Stars.
15,928	stars from the Smithsonian Astrophysical Observatory (SAO) catalog of stars brighter than 7th magnitude.
351	alignment stars for the LX200 telescope.
110	Messier objects; the complete listing.
8	major planets from Mercury to Pluto.
64,359	objects, total

LX200
SCHMIDT-CASSEGRAINS

☐ Use the GO TO command to *find and center an object in the field of a 4mm eyepiece.*

☐ With other telescopes, acquiring even bright objects on the chip of a CCD imager is generally a chore at best, searching and slewing by trial-and-error until at last the object is positioned on the chip. The LX200's High-Precision Pointing places *every* object on *every* CCD chip *every* time.

☐ Suppose you wish to CCD-image a supernova in an 18th magnitude galaxy—a galaxy invisible *except* through the process of CCD imaging. With Meade High-Precision Pointing, the galaxy can be placed on the chip of every commercially-available CCD unit.

☐ Photographing or imaging faint objects such as the planet Pluto, or comets and asteroids near the photographic limit of the telescope, and plotting the motion of these objects night-to-night, now becomes practical, since the photograph or image may be taken *without the observer ever having seen the object visually,* but knowing that the LX200 will place the object precisely in the telescopic field.

SPECIFICATIONS: 8", 10", and 12" LX200's—Each complete telescope includes 8" or 10" (f/6.3 or f/10) or 12" f/10 Schmidt-Cassegrain optical tube assembly with EMC super multi-coatings; heavy-duty fork mount with 4" polar ball bearing, dual-axis 5.75" worm gears, and multi-function control panel display on the drive base; manual and electric slow-motion controls on both axes; keypad handheld controller with digital readout display, permanently programmable Smart Drive™, 9-speed drive controls on both axes (7-speed on 12"), High-Precision Pointing, and GO TO controller; 64,350-object onboard celestial software library; 25 ft. power cord and adapter for telescope operation from 115v.AC (for field operation from any 12v. auto cigarette lighter plug, use the Meade #1812 Electronic DC Adapter, a 4-oz. unit available optionally); 8 x 50mm viewfinder with crosshairs; 1.25" diagonal prism (8", 10") or 2" diagonal mirror with 1.25" adapter (12"); Series 4000 Super Plössl 26mm eyepiece; standard field tripod (8", 10") or giant field tripod (12"); foam-fitted carrying case; complete operating instructions.

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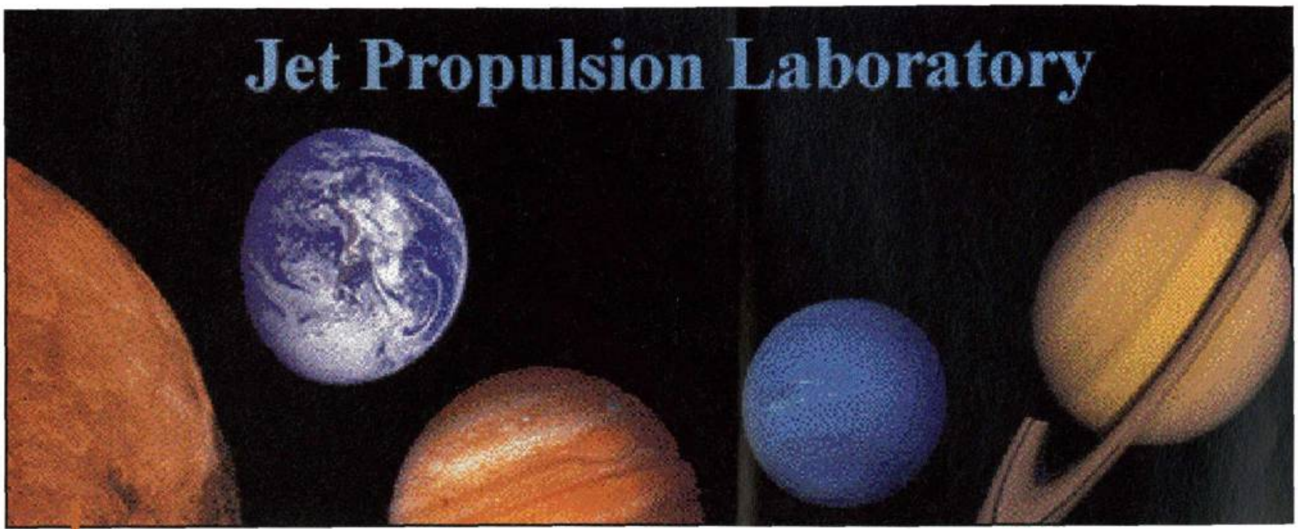

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COVER 20 Hubble Sees Mars

ON THE COVER

CRATERS, CLOUDS, AND VOLCANOS dot the face of Mars in this Hubble image. Just left of center are craters filled with streaks of dark dust. Poking through clouds on the right edge is the 25-km-high (15-mile) volcano Ascraeus Mons. For more HST images of Mars, turn to page 20. Photo by Steve Lee and Mike Wolf (University of Colorado) and Jim Bell (NASA Ames).

30 The Sun's Fab Four

Ceres, Pallas, Juno, and Vesta weave a compelling tale about how minor planets form and evolve. By Alan Stern.

40 A Galaxy of News

Recent findings in the cosmos: galaxies collide head-on, quasars blaze with no host galaxy, and spirals form in miniature versions. By David Bruning.

46 A Friend for Life?

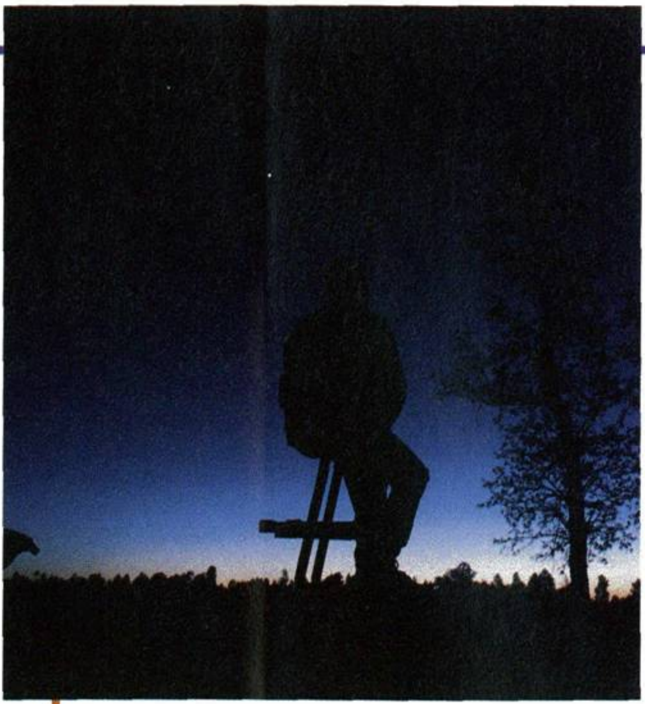
From molecules to amino acids to proteins to life — it happened on Earth. Could it have happened elsewhere too? By Julie Paque.

54 Sky Almanac

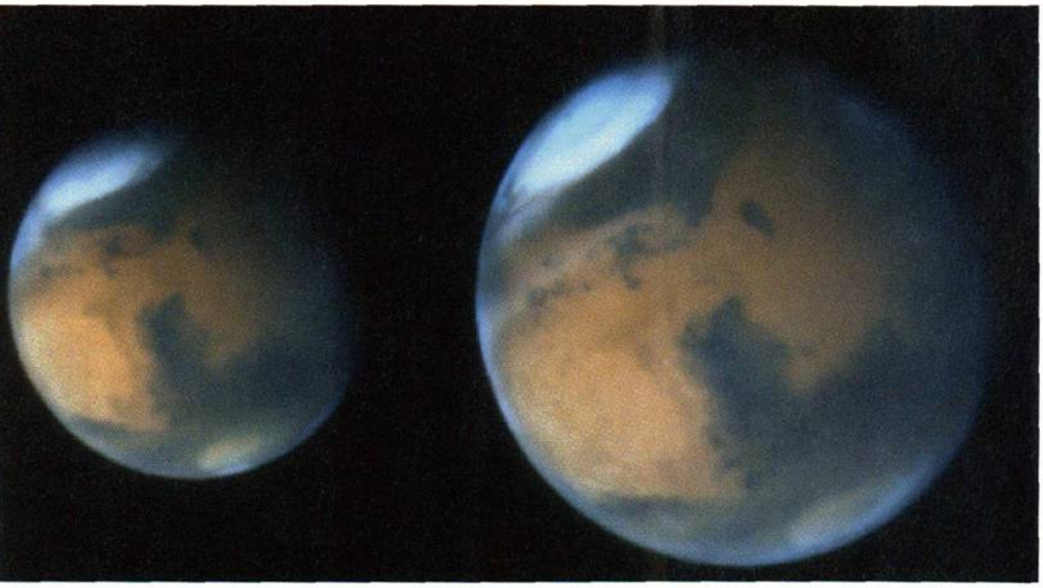
The spotlight this month falls on Jupiter, which shines brightly all night, but don't miss the return of Comet d'Arrest. By Deborah Byrd and Rick Shaffer.

Kirk Borne, STScI, and NASA

40 **Naked Quasars & Other News**


Tom Polakis

64 **Going Beyond Deep-Sky Basics**


Steve Lee and Mike Wolf, (University of Colorado); Jim Bell, NASA Ames.

64 Deep Sky on Four a Day

The Herschel 400 may not have the renown of the 100-plus Messier objects, but they offer rewarding targets for a whole year's worth of deep-sky-observing pleasure. By Tom Polakis.

70 The Vanishing Rings of Saturn

Backyard observers can watch Saturn's appearance change from one week to the next as the planet's rings turn edge-on for the first time in 15 years. By Julius Benton and Richard Talcott.

74 Blasting Along the InfoBahn

You've heard a lot about the Internet, now find out how to get on and what it offers astronomy enthusiasts. By David Bruning.

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BEHIND THE SCENES

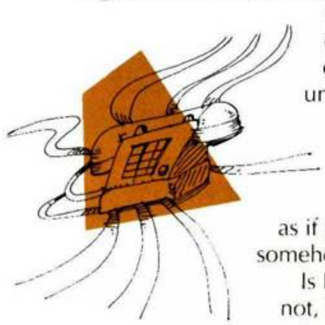
It's Virtually the Entire Universe

http://...
html...
ftp...
Point to the URL at...

OK, it looks like gibberish. But if you steer your computer past the superficial weirdness, there's a marvelous universe awaiting.

Starting on page 74 of this issue, ASTRO's computer doyen Dave Bruning takes you on a brief tour of the wonders of the Internet, astronomy subset. The Internet is famous for being so big, so all-inclusive that it's hard to wrap your mind around the subject. Dave's article certainly won't cover the entire "virtual universe," but it will get you started on exploring it.

Virtual universe, real universe — what do they have in common? More than you might think. For one thing, while sitting at a keyboard and studying images of galaxies on a monitor may not feel like real astronomy, it actually comes a lot closer to what the pros do than looking into the eyepiece of an amateur telescope does. Second, exploring the universe on-line gives your astronomy experience a whole new dimension. And, frankly, it's fun.



This last point is important to keep in sight. When computer-controlled telescopes began to appear, some people groused that they made finding objects too easy. It's as if peering through a finder and getting a crick in the neck were somehow an essential part of seeing NGC 188.

Is Internet astronomy going to get the same bum rap? I hope not, but I sometimes wonder. I'm always surprised when backyard astronomers get really upset if someone doesn't do astronomy just *their* way — as if there were only one true path to the universe. Hey, folks, lighten up! This is serious play we're engaged in here — no grouching allowed.

On-line astronomy is here to stay. And ASTRONOMY will be covering it in whatever ways seem useful or appropriate. Drop us a line, by snail-mail or e-mail (my address is below) — and let us know what you'd like to see.

Sincerely,

Robert Burnham

Robert Burnham
Editor
rburnham@astronomy.com

LETTERS

The Real Story

Recently I've seen much debate over whether the term "Big Bang" is appropriate to describe the prevailing cosmological theory. One argument against this name is that it was coined by British astronomer Fred Hoyle, a longtime opponent of the theory. It is alleged that he meant "Big Bang" to be pejorative.

In fact, this isn't true. For my book *The Alchemy of the Heavens*, I interviewed Hoyle to learn about his pioneering work on the origin of the chemical elements. But he also told me the real story behind naming the Big Bang. Hoyle coined the term in 1950 on the BBC, and says his motivation was quite different from that claimed by the popular press.

Hoyle says, "The BBC was all radio in those days, and on radio, you have no visual aids, so it's essential to arrest the attention of the listener and to hold his comprehension by choosing striking words. There was no way in which I coined the phrase to be derogatory; I coined it to be striking, so that people would know the difference between the steady state model and the big bang model."

Hoyle obviously succeeded. So striking is the term that it is still used today, even by those, like Hoyle, who disagree with the theory. — *Ken Croswell, Berkeley, California*

Unselfish Astronomy

Amateurs could do a world of good by helping young people get started observing the sky. Astronomy can be a frustrating hobby for young people to take up, and it's mainly our fault as amateur astronomers. Join a club and look who's there — a bunch of old guys, with few young people or women.

The fate of the beginner is dismal at best, as few of the old guys want to answer "dumb questions." Most alarmingly, some backyard observers in clubs now

(continued on page 12)

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SALE!

Buy a Meade® 8" or 10" Schmidt-Cassegrain at a SPECIAL LOW PRICE *and* receive 2 eyepieces — a $75 value — FREE!

Through June 30, 1995, you can save on a Meade 8" or 10" Standard Series Schmidt-Cassegrain, and, in addition, receive two Meade Multi-Coated Eyepieces FREE!

SPECIAL PRICES**

8" Model 2080B, complete $1195

10 Model 2120B, complete 1495

Packing & shipping: 8"—$75; 10"—$95.

***FREE Modified Achromatic Eyepieces:** With every 2080B or 2120B, Meade Instruments will include MA9mm and MA12mm eyepieces, (a $75.90 value) at no additional cost. *This free offer is valid between April 20 and June 30, 1995. Shown in photo:* MA9mm, MA12mm, and standard-equipment MA25mm eyepieces.

**Prices shown are suggested U.S. national mail-order retail prices, not including any applicable sales taxes or credit card charges.

8" Model 2080B:
$1195, *including*
equatorial wedge
and field tripod.

10" Model 2120B:
$1495, *including*
equatorial wedge
and field tripod.

Meade Standard Series Models 2080B and 2120B include a wide range of features not available on any other Schmidt-Cassegrains in their price range:

Multi-Coated Optics: Meade EMC Multi-Coatings *increase correcting plate light transmission to 99%+.* Competing Schmidt-Cassegrains include only a single layer coating on the corrector.

Worm-Gear Drive Systems: *Large 5.75" R.A. worm gears* included on Models 2080B and 2120B permit tracking that is smooth and precise—a significant improvement on the spur gear drives supplied with other brands of SCT's.

Full-Length, Variable-Height Field Tripod: Competing Schmidt-Cassegrains charge extra for the tripod. The Meade Field Tripod is *included as standard equipment,* and is, by far, the most rigid in the industry.

Optical Systems provided with Models 2080B and 2120B are *identical in every respect to legendary Meade 8" and 10" LX200 optics.* There are no finer Schmidt-Cassegrain optics manufactured.

TO ORDER: Call or visit your Meade Advanced Products dealer. ***Prompt delivery on both models.***

Specifications: Models 2080B, 2120B—Includes 8" or 10" f/10 optical tube assembly with EMC multi-coatings; fork mount with setting circles, manual slow-motion controls, and locks on both axes; 5.75" worm gear motor drive system (115v.AC/60Hz); eyepiece-holder (1.25"); diagonal prism; multi-coated MA9mm*, MA12mm*, and MA25mm eyepieces; 6 x 30mm viewfinder (8 x 50mm on 10"); standard equatorial wedge; variable-height field tripod; 6 ft. power cord; operating instructions.

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STARFINDER™ DOBSONIANS

Now you can buy a Dobsonian telescope with quality Meade® optics and components—at a fraction of the price you'd expect to pay.

And receive a $125 Accessory Package for only $49.95!

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10" f/4.5
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Shown with optional #637 6 x 30mm or #545 8 x 50mm Viewfinders

6" f/8
$325.

SPECIAL ACCESSORY OFFER!

At the time you order any Starfinder 6", 8", 10", 12.5", or 16" Dobsonian Telescope, you can buy **two additional Meade multi-coated Modified Achromatic MA9mm and 12mm eyepieces *and* the Meade #637 6 x 30mm coated achromatic viewfinder with metal bracket for a *total* of only $49.95! Purchased separately, the 2 additional eyepieces and viewfinder sell for $125.85!** *(Shown in photo: MA9mm, MA12mm, and standard-equipment MA25mm eyepieces, with #637 6 x 30mm viewfinder.)* Offer valid until further notice.

Starfinder Dobsonian 16

16" f/4.5
$1195.

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See the Meade General Catalog for details.

Includes giant #682 focuser; shown with optional 8 x 50mm viewfinder.

Compare Meade Starfinders *feature-for-feature* with other similarly priced Dobsonians!

- **Primary and Secondary Mirrors of Low-Expansion Pyrex® glass!** Unlike the plate-glass optics of other Dobsonians that can become thermally unstable (especially in larger apertures), Meade Dobsonians include the *exact same* professional-quality Grade-A, fine-annealed Pyrex® optical systems used on Meade Starfinder Equatorial Reflectors. Optics that meet the theoretical limits of resolution for their apertures.
- **Precision Rack-and-Pinion Focuser!** An industry-standard full-size rack-and-pinion system with 2.6" of focus travel.
- **Fully-Adjustable 4-vane Secondary Mirror Systems!** *Rigid 4-vane systems* that permit precision alignment of the secondary mirror to the primary mirror.
- **Rigid, Durable, Beautiful Dobsonian Mountings!** Mountings that provide extremely smooth motions of the telescope in both altitude and azimuth. Both telescope axes ride on zero-backlash Teflon/Nylon bearings, facilitating the location and tracking of celestial objects anywhere in the sky. Each mount is manufactured of cabinet-quality materials and designed for a lifetime of use. Handles are provided for easy portability.
- **Optical Tubes:** Starfinder Dobsonians include the same strong, spiral-wound optical tubes used on Starfinder Equatorials *(facing page)*. All telescopes include a multi-coated MA25mm eyepiece as standard equipment. Each tube is factory pre-drilled for the optional 6 x 30mm or 8 x 50mm viewfinder.
- **Performance!** A Meade Starfinder Dobsonian or Equatorial Telescope opens up the skies to an extremely wide range of serious visual observing: all 110 Messier objects, thousands of NGC objects–nebulae, galaxies, star clusters, in all their variations of form, color, and extent, as well as the Moon and planets in stunning, high-resolution detail. Starfinder Dobsonians are telescopes for visual observing; motor-driven Starfinder Equatorials may be used, in addition, for lunar and planetary photography and even for limited deep-space astrophotography.
- **Packing and UPS Shipping Charges:** to any address in the 48 states: 6"–$39; 8"–$49; 10"–$69; 12.5"–$79. 16"–$45 packing, shipped truck freight collect.
- **To Order:** Contact one of the authorized mail-order dealers on the facing page.

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STARFINDER™ EQUATORIALS

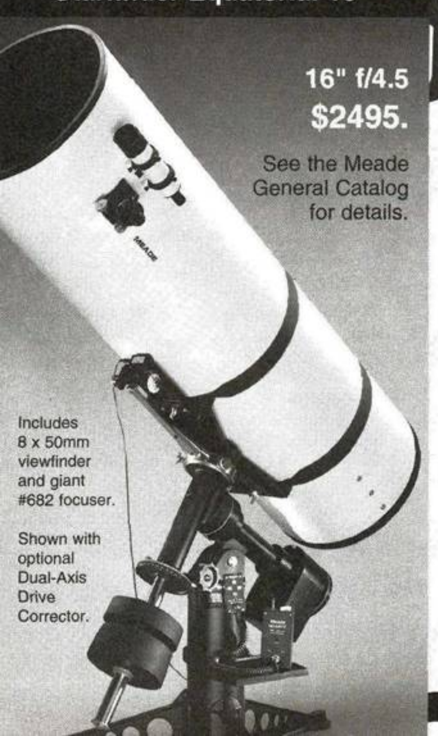
Complete **6", 8", and 10" telescopes with equatorial mounts, motor drives, setting circles, and full accessorization... from $599.95!**

6" f/8
$599.95

8" f/6
$699.95

10" f/4.5
$799.95

Starfinder Equatorial 16



16" f/4.5
$2495.

See the Meade General Catalog for details.

Includes 8 x 50mm viewfinder and giant #682 focuser.

Shown with optional Dual-Axis Drive Corrector.

Standard equipment on 6", 8", and 10" models includes:

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- **Precision Equatorial Mount:** Manufactured of machined aluminum to tolerances of .001" or better, with 4"-dia. pier and die-cast tripod legs, for rock-solid support of the optical tube. The telescope moves effortlessly from object-to-object on precision bearing surfaces. Polar and declination shafts are 1" solid steel. Setting circles on both axes facilitate the location of faint objects directly from their catalogued coordinates.
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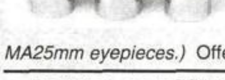

- **Packing and UPS Shipping Charges:** to any address in the 48 states: 6"–$65; 8"–$75; 10"–$90. 16"–$55 packing, shipped truck freight collect.
- All prices shown are suggested USA mail-order retail prices, not including any applicable sales taxes.
- **Meade 1995 General Catalog** — $3.00 postpaid—is available from any authorized Meade dealer or directly from Meade Instruments.
- For further information call Meade Instruments at 714-756-2291 or contact one of these authorized mail-order dealers:

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CALIFORNIA TELESCOPE COMPANY, Burbank, CA.
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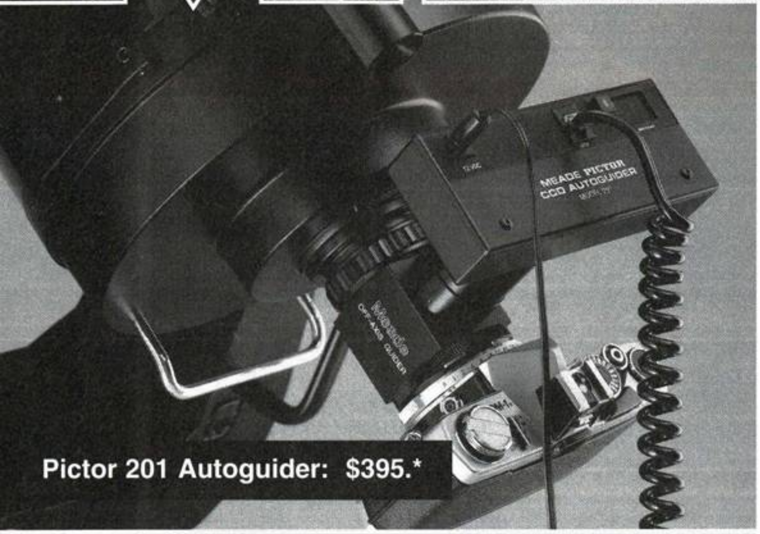
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MEADE
OFF-AXIS GUIDER

Pictor 201 Autoguider: $395.*

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CCD IMAGING SYSTEM

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MEADE PICTOR
CCD IMAGING SYSTEM

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Pictor 216 Autoguider/Imager: $1195.

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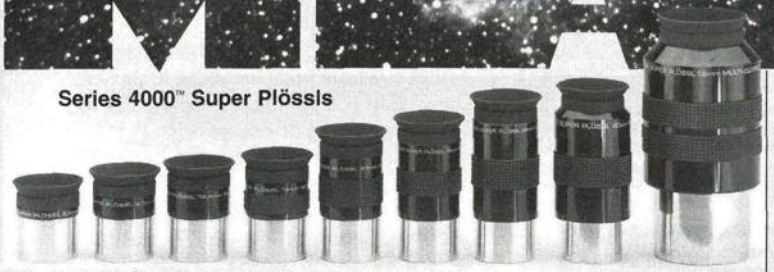
Series 4000™ Super Plössls



Meade 4-element Super Plössls, updated and redesigned to utilize the latest in optical glass-types for 1994, are the finest general-purpose eyepieces available. For observing hairline lunar and planetary detail, splitting close doubles, or for deep-space; guaranteed to deliver more contrast and image sharpness than any other brand. Rubber eyeguards fold down for eyeglass wearers–a feature not available on competing brands. Multi-coated. All focal lengths through 32mm are parfocal.

Super Plössls (SP; 4-elements; 1.25"; 52°):

6.4, 9.7, 12.4, 15, 20, 26mm	each:	**$87.95**	(3.45)
32mm (52°); **40mm** (44°)	each:	**109.95**	(3.79)
56mm (52°; 2")		**229.95**	(5.48)

Series 4000™ f/6.3 Focal Reducer/ Field Flattener

Manufactured to exclusive Meade optical designs; threads on to any Meade or Celestron Schmidt-Cassegrain rear cell and converts f/10 scopes to f/6.3 (or f/6.3 SCT's to f/4), while significantly flattening the field. Use with SCT visual or photo accessories. Actual visual field is increased by 56%, for fine wide-field views of star fields and nebulae. In astrophotography, reduces exposure times by about 50%, while producing an actual field diameter of 1.5" at the film plane. A tremendous aid with CCD imagers in reducing image size for locating and centering images on CCD chips. 4-element optics; multi-coated; 41mm clear aperture.

$129.95 (3.60)

Series 4000™ Super Wide Angle

For exquisite wide-angle images at low-to-medium powers, ideal for star fields, galaxies, and other deep-space phenomena. SWA 13.8, 18, and 24.5mm are superb complements to the #140 Barlow.

Super Wide Angle (SWA; 6-elements; 1.25"; 67°)–**13.8mm: $159.95** (3.49); **18mm: 169.95** (3.69); **24.5mm: 199.95** (3.89); **32mm** (2"): **279.95** (4.78); **40mm** (2"): **339.95** (5.48)

Series 4000™ Ultra Wide Angle

The ultimate eyepieces; extreme image sharpness over an amazing 84° field.

Ultra Wide Angle (UWA; 8-elements; 1.25"; 84°)–**4.7mm: $179.95** (3.29); **6.7mm: 219.95** (3.29); **8.8mm** (1.25"/2"): **269.95** (4.78); **14mm** (1.25"/2"): **329.95** (5.48)

Series 4000™ #140 2x Apochromatic Barlow Lens

The most advanced Barlow Lens available for commercial telescopes; includes 3-element, air-spaced optics, multi-coated. Unmatched in image resolution, contrast and color correction. Accepts 1.25" eyepieces. Lens dia. 28mm; clear aperture 26mm.

$79.95 (3.29)

SALE!

Series 3000 Plössls Save up to 30%!

Now you can buy Meade *multi-coated* Series 3000 Plössl Eyepieces—the finest moderately-priced eyepieces ever manufactured—at never-before prices!

See complete eyepiece description elsewhere on this page.

Buy one or buy a dozen!
No minimum, no maximum!

Series 3000 Plössl 5, 6.7, 9.5, 16, or 25mm:

each **$39.95** (3.45)

(regularly $46.95 to $57.95)

Series 3000 Plössl 40mm:

each **$69.95** (3.79)

(regularly $79.95)

This special offer is valid between November 20, 1994 and May 31, 1995, at participating Meade dealers in the U.S.A. and is subject to eyepiece availability.

Series 3000™ Plössls

The very latest in eyepieces from Meade optical designers, new Meade Series 3000 Plössls yield the finest image corrections obtainable from the classical 4-element Plössl design. Available in a wide range of focal lengths from 5mm through 25mm. All five eyepieces are parfocal, so that, at most, only slight refocusing of the image is necessary from eyepiece to eyepiece. Unlike competing moderately-priced Plössls, Meade Series 3000's are **multi-coated** for maximum light transmission and image contrast. Chrome-plated brass barrels are threaded for standard filters. Manufactured exclusively for Meade Instruments by one of Japan's leading lensmakers, Series 3000 Plössls produce excellent results on reflectors, refractors, and Schmidt-Cassegrains of any focal ratio.

Series 3000 Plössls (4-elements; 1.25"; 50°)

5, 6.7, 9.5, 16, 25mm each: **$57.95** (3.45) **Any 2: $52.95** each; **Any 3: $48.95** each; **Any 4 or 5: $46.95** each.

Series 3000™ Plössl 40mm

A perfect complement to the Series 3000 Plössls at left, this all-new Plössl 40mm produces spectacular low-power, wide-field results with any telescope. Includes classical 4-element Plössl optics, multi-coated. Barrel dia. 1.25"; threaded for filters. Apparent field: 44°.

$79.95 (3.79)

Series 4000 Photo-Visual Color Filters (1.25")—Made of purest crown optical glass, dyed in the mass. For increased contrast and resolution on the Moon and planets. Thread into the barrels of virtually all 1.25" eyepieces sold today. Fully coated.

#8 Lt. Yellow; #11 Yellow Green; #12 Yellow; #21 Orange; #23A Lt. Red; #25A Red; #38A Dark Blue; #47 Violet; #56 Lt. Green; #58 Green; #80A Blue; #82A Lt. Blue

each **$14.95** (2.29)

Moon Filter #ND96–Reduces brightness by 87%.	**16.95**	(2.29)
Set #1–4 filters: #12, #23A, #58, #80A	**54.95**	(2.98)
Set #2–4 filters: #11, #25A, #47, #82A	**54.95**	(2.98)
Set #3–4 filters: #8, #21, #38A, #56	**54.95**	(2.98)
Sets #1 & #2–8 filters	**99.95**	(3.45)
Sets #1, #2, & #3–12 filters	**144.95**	(3.79)

#911B
#910B
#908B
#911N
#910N
#908N

Series 4000 Nebular Filters—Premium multi-layer interference filters, the finest obtainable. Use broadband ("B") filters to block most forms of light pollution; use narrowband ("N") filters in heavily light-polluted areas or for extremely high-contrast observing of faint nebulae.

#908B–Threads into 1.25" eyepieces, 26mm dia.	**79.95**	(2.98)
#910B–Threads into 2" eyepieces, 44mm dia.	**119.95**	(3.29)
#911B–Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia.	**99.95**	(3.29)
#908N–Threads into 1.25" eyepieces, 26mm dia.	**89.95**	(2.98)
#910N–Threads into 2" eyepieces, 44mm dia.	**129.95**	(3.29)
#911N–Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia.	**119.95**	(3.29)

World's Most Advanced Illuminated Reticle Eyepiece

Series 4000 Plössl 9mm, with rubber eyecup and micrometric X-Y positioning of the reticle within the field. Greatly facilitates locking on the guide star. Sharp high-power imaging, excellent eye relief. Wireless red LED illuminator with adjustable brightness control. **Internal batteries included.** Multi-coated optics. Bullseye reticle. 1.25"

$149.95 (3.45)

Series 4000 Plössl 9mm—Same as above but with 6 ft. cord and plug for Meade LX3, LX5, LX6, LX100, LX200, and APO power panels, in place of wireless illuminator.

$129.95 (3.45)

MA 12mm Illuminated Reticle Eyepiece

Excellent 3-element optical system, long eye relief, fully coated, with double crossline reticle. Wireless red LED illuminator and variable brightness control. **Batteries included.**

$99.95 (3.45)

MA 12mm—Same as above but with cord and plug for Meade telescopes with power panels, in place of wireless illuminator.

$79.95 (3.45)

2" Diagonal Mirror

#929: Permits use of wide-field 2" oculars. Threads on to rear cell of Meade and Celestron SCT's. Includes multi-coated precision optical flat made at the Meade factory; with 1.25" eyepiece adapter. **$99.95** (3.79)

Camera Adapters (1.25" & .965")

Professional-quality adapters for rigid coupling of telescope-to-camera. Use for either Eyepiece-Projection or Prime Focus. Precision-machined of aluminum and brass, threaded for filters. Use with T-mount, available separately.

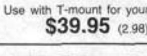
.965": $27.95 (2.98) **1.25": $29.95** (2.98)

Variable-Projection Camera Adapter (1.25")

Machined sliding cell allows variable projection power in eyepiece-projection photography; permits precise selection of correct photo power in lunar and planetary photography; threaded for filters. Use with T-mount for your camera.

$39.95 (2.98)

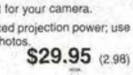
Tele-Extenders



For Eyepiece-Projection photography with any Meade or Celestron SCT. Threads on to any eyepiece-holder. Use with T-mount for your camera.

Basic Tele-Extender: *(above)* Fixed projection power; use with eyepiece for lunar and planetary photos.

$29.95 (2.98)



Variable Tele-Extender: Sliding cell, with lock, permits wide range of projection magnifications with the same eyepiece.

$39.95 (2.98)

T-Adapters for SCT's

For Prime Focus photography with any Meade or Celestron SCT. Use with T-Mount for your 35mm camera.

$26.95 (2.98)

2x Telenegative Barlow (1.25")

#122: Doubles eyepiece power with sharp, high-resolution, high-contrast imaging on telescopes of all types. 27mm dia. (26mm clear aperture). Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multi-coated. 1.25"

$47.95 (3.45)

2x-3x Variable Barlow (1.25")

#127: Precision internal sliding lens assembly permits continuously variable power settings between 2x and 3x. Engraved scale indicates power in use. Yields bright, sharp, high-contrast images on telescopes of all types. Multi-coated; 1.25"

$59.95 (3.45)

2x Short-Focus Barlow (1.25")

#126: Only 2.5" long, the #126 works well with any telescope accepting 1.25" eyepieces, even those with limited focus range. Maintains the high image quality of the #122, above. Insert the #126 into star diagonal for 2x or insert star diagonal into #126 for 3x. 26mm clear aperture. Multi-coated.

$47.95 (3.45)

Modified Achromatic Eyepieces

An improvement on the traditional Kellner design, these 3-element Modified Achromatic eyepieces give sharp, faithful, well-corrected images of the moon, planets, and deep-space at an economical price. Multi-coated; threaded for filters; 1.25" barrel diameter. Apparent field: 40°. **MA 9, 12, 25, 40mm.**

each: **$37.95** (2.98)

HOW TO ORDER

- Prices shown are suggested USA mail-order retail prices and do not include any applicable sales taxes.
- Suggested shipping and handling charges to the 48 states by UPS or US Mail shown in ( ) next to each price.
- Meade accessories may be ordered from any Meade Advanced Products Dealer. **The following national mail-order dealers carry all Meade accessories in-stock for immediate shipment:**

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CALIFORNIA TELESCOPE CO., Burbank, CA.
Orders: 800-843-4780; Info.: 818-505-8424.

CITY CAMERA, Dearborn, MI.
Orders: 800-359-5085; Info.: 313-846-3922.

FOCUS CAMERA, Brooklyn, NY.
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LUMICON, Livermore, CA.
Orders: 800-767-9576; Info.: 510-447-9570.

SHUTAN CAMERA & VIDEO, Chicago, IL.
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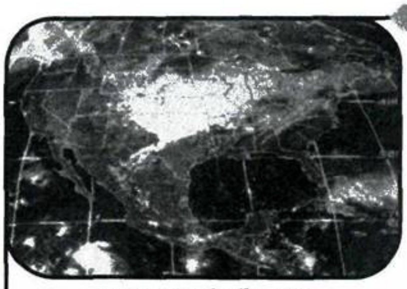

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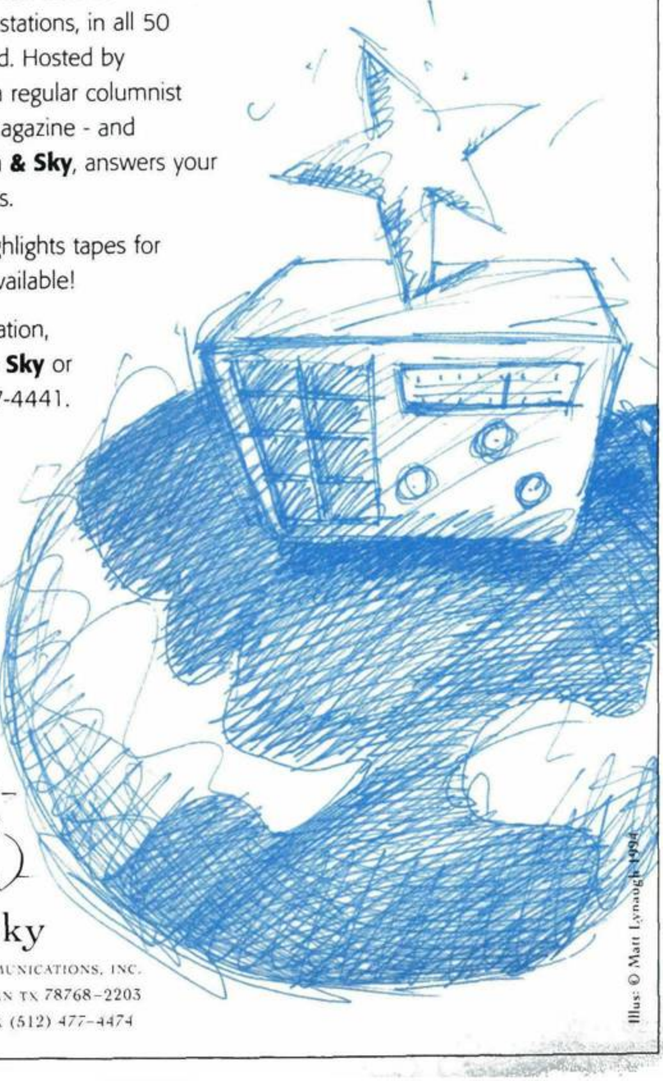

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LETTERS

charge for views through their scopes! It brings a whole new meaning to pay-per-view. Can you blame newcomers to the hobby for being discouraged?

I share my telescopes, especially with youngsters, every chance I get. I've given countless people their first look at the Moon or Saturn or a galaxy. I refuse to contribute to the death of amateur astronomy.

I won't join a club and become a boring intellectual. But I will answer all of the dumb questions I hear, and hold kids up to the eyepiece to take in their first looks at the Moon. — *Bob Cook, Renton, Washington*

All Flashed Out and Nowhere To Go

In the last few years a disturbing trend has removed large portions of the night sky from amateur astronomers. The culprits are bright white warning strobe lights on radio, telephone, microwave, and television towers. The white strobe lights are replacing older, dimmer red lights. Because they are placed on top of towers that are often 200 feet or higher, they can interfere with astronomical viewing up to five miles away.

I live in Venango County, Pennsylvania, 50 miles from a large metropolitan area. The county has a couple of small cities with populations less than 15,000. Because the cities are in valleys, our area offers relatively dark skies.

But three towers in the county have converted to white strobe lights within the last few months, and now we face an end to dark skies.

Our local astronomy club has worked with the owner of one tower, AT&T, attempting to convert its tower back to red light. AT&T has thus far been sympathetic. The astronomy club has donated funds to make the change, and it appears AT&T may change the light.

But the white strobe lights apparently use less energy than the red lights, so convincing companies to revert to the red lights may prove challenging. If this trend continues, we may be in for brightening skies all across the country. Is there anything more we as amateur astronomers can do? — *Ron Harvot, Jr., Franklin, Pennsylvania*

High-Tech Gear Necessary?

The high-tech devices pervading the market are ruining the spirit of the real meaning of recreational astronomy, feeling a close, personal encounter with the universe. — *Jorge I. Cerritos, Winnipeg, Manitoba*

ON THE EVENING OF August 21, 1993, Steve Bisque in GOLDEN, COLORADO established modem contact with the 24-inch telescope at the Mt. Wilson Observatory *outside Pasadena...*

...he also grabbed a slice of history.

Using TheSky™ astronomy software and simple mouse clicks, Steve ordered the California telescope, more than 1,000 miles distant, to slew and lock on a medley of celestial objects. He collected more than a dozen images without a hitch.

It's hard to overstate this achievement. The applications of remote operation for professional, amateur, and scholastic astronomers are staggering.

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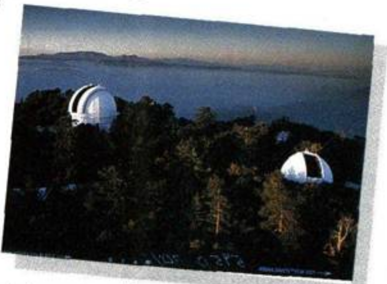
*Still, we're no less proud of TheSky's other contributions to astronomy. Take, for instance, its highly acclaimed professional-quality star charts, CCD image processing, and stunning databases containing up to 19-million objects (including the Guide Star Catalog).**

There are simpler joys too, like its user friendly Windows™ interface, optional CD-ROM media, and simple upgrade path to professional versions. Not to mention lightning execution.



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Thousand Oaks Optical solar filters are recognized around the world for their quality, consistent density and even coating across the entire aperture. We specialize in solar filters only and are the largest solar filter manufacturer in the world. Filters are available to fit all brands of telescopes and binoculars. **Thousands of our filters are in use around the world. The preferred choice of telescope dealers and exclusively used by NASA aboard the Space Shuttle. Other professional users include:** ABC, CBS, NBC & CNN News, Nova, *Discovery, National Geographic* and most major universities and observatories throughout the world.

GLASS (Full Aperture) Type 1

Made from high quality hand select glass, machine polished and **TRIPLE COATED** with a Nickel-Chromium alloy. Mounted in a machined aluminum cell ready to attach to telescope. Solar image is yellow-orange. No secondary filtering is necessary.

Aperture	Mounted	Aperture	Unmounted
2.4"	$49.00	2.4"	$39.00
3.1"	52.00	3.1"	42.00
3.5" to 4"	59.00	3.5 to 4"	49.00
4-1/4" to 5"	74.00	4-1/4" to 5"	64.00
6"	79.00	6"	69.00
8"	95.00	8"	85.00
10"	109.00	10"	99.00
11"	119.00	11"	109.00
12.5" to 13.1"	149.00	12.5" to 13.1"	129.00
14"	169.00	14"	149.00

40mm to 80mm Binoculars - Mounted .... $92.00 pr.

GLASS (Full Aperture) Type 2

Same as type 1, except stainless steel is combined in the coating to provide an even more durable surface that highly resists wear due to excessive handling and ultraviolet radiation. Solar image is also yellow-orange.

Aperture	Mounted	Aperture	Unmounted
2.4"	$62.00	2.4"	$52.00
3.1"	65.00	3.1"	55.00
3.5" to 4"	76.00	3.5 to 4"	66.00
4-1/4" to 5"	96.00	4-1/4" to 5"	86.00
6"	105.00	6"	95.00
8"	125.00	8"	109.00
10"	139.00	10"	129.00
11"	149.00	11"	139.00
12.5" to 13.1"	179.00	12.5" to 13.1"	159.00
14"	199.00	14"	179.00

40mm to 80mm Binoculars - Mounted .... $115.00 pr.

GLASS (Full Aperture) Type 3

Coated to a neutral density of 4 for serious astrophotographers who desire the shortest possible shutter speeds with slow films. Solar image and optical quality same as type 1 & type 2. Type 3 filters are for photographic use only.

Aperture	Mounted	Aperture	Unmounted
2.4"	$79.00	2.4"	$65.00
3.1"	82.00	3.1"	69.00
3.5" to 4"	99.00	3.5 to 4"	79.00
4-1/4" to 5"	125.00	4-1/4" to 5"	110.00
6"	135.00	6"	115.00
8"	159.00	8"	139.00
10"	172.00	10"	152.00
11"	199.00	11"	179.00
12.5" to 13.1"	229.00	12.5" to 13.1"	209.00
14"	259.00	14"	239.00

Types 1 & 2 are for unlimited visual use and general photographic use. Instructions included with all filters, including tips on solar photography.

1/4 WAVE PREMIUM FILTERS

(Type 2 coating)

Aperture	Mounted	Aperture	Unmounted
2.4"	$129.00	2.4"	$119.00
3.1"	199.00	3.1"	189.00
3.5" to 4"	269.00	3.5 to 4"	259.00
5"	349.00	5"	339.00
6"	399.00	6"	389.00

Add $15.00 for Type 3 coating.

Please call or write for available sizes and pricing.

5 year warranty on Type 1, 2, 3 & 1/4 wave filters.

H-ALPHA PROMINENCE FILTERS.
Priced from $699-$859 complete & ready to attach to telescope. Please call or write for additional information.

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ORDERING INFORMATION: Glass filters are shipped free within the continental U.S. (Please call or write for shipping cost outside of the U.S.) Payment may be made by personal check, bank check or money order. We also accept **VISA, MasterCard and American Express.** (No bank hold on personal checks.) **PLEASE SPECIFY TELESCOPE BRAND AND/OR OUTSIDE DIAMETER MEASUREMENT OF TELESCOPE TUBE.** The cost of the filter is determined by the telescope aperture. The mounting cell fits over and around the end of the telescope tube (friction fit). Unmounted filters are the glass filter without a mounting cell.

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LETTERS

Perseid Problems

The December 1994 issue contained a number of observations of the Perseid meteor shower last August. As some of them indicate, the anticipated good Perseid show materialized early on August 12. My comments published in the December issue regarding Philip Bagnall's article ("A Stormy Perseid Forecast," August 1994) were somewhat garbled.

To set the record straight, I'd like to point out that in his article Philip Bagnall did correctly refer to the early peak. Where he let the UK-based readership down was in failing to mention the normal peak, which occurred later on August 12-13, as seen from Europe.

I appreciate that letters are edited for length and clarity, but the editing in this case missed the point! — *Neil Bone, Chichester, West Sussex, England*

Reports of Polaris' Death Greatly Exaggerated

Robert Zimmerman's article "Polaris, the Code-Blue Star" (March 1995) states that Polaris stopped pulsating last year as predicted. On the one hand, it's painful to admit that a prediction I was a cosigner to failed to come true. On the other, I'm happy to announce that Polaris still feebly pulses on. As soon as the prediction by Don Fernie, Sara Seager, and me went to press, the pulsations stabilized nicely and have held perfectly constant since.

Readers may wish to look over the review of Polaris' recent behavior by Jaymie Matthews in the *Journal of the Royal Astronomical Society* (August 1994). Since then we have obtained additional radial velocity measurements here at the David Dunlap Observatory, measures much higher in precision than previous studies.

We find the peak-to-peak amplitude holding constant at 1.5 kilometers per second. This is half what it was in 1980 and a quarter of what it was in 1950, but at present there's no indication of a continuing trend.

Congratulations must go to the celestial paramedics. — *Karl Kamper, David Dunlap Observatory, University of Toronto, Richmond Hill, Ontario* □

ASTRONOMY welcomes feedback. Send your letters to ASTRONOMY Letters, P.O. Box 1612, Waukesha, WI 53187-1612, or on the Internet, use ***72000.2704@CompuServe.com****. Letters may be edited for length and clarity.*

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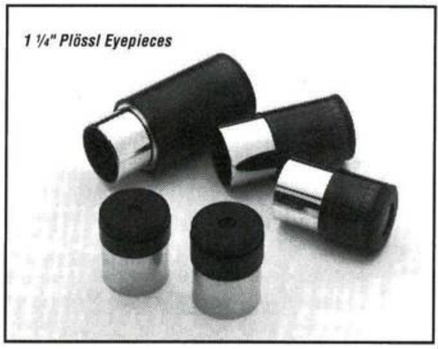
1 ¼" Plössl Eyepieces

PLÖSSL EYEPIECES

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Focal Length	Apparent Field	Eye Relief	Sizes	
7.5mm	52°	5mm	.96",	1¼"
10mm	52°	6.5mm	.96",	1¼"
17mm	52°	13mm	.96",	1¼"
26mm	50°	22mm	.96",	1¼"
40mm	46°	31mm	1¼"	

Ultima Barlow Lens–1.25

ULTIMA EYEPIECES

Celestron's top of the line eyepieces which use a hybrid design of 4 to 7 elements. Features long eye relief and a wide field. **Full** multi-coating on each air-to-glass surface enhances contrast levels. Computer designed to keep the following aberrations to an absolute minimum: spherical, coma, astigmatism, distortion, color, field curvature and spherical of the exit pupil. Inside and all lens edges are blackened to keep out reflected light. The outside is flat black with rubber grips. Included are rubber eyecups for comfort and to keep out extraneous light. Threaded barrels accept thread-in filters. Lens and barrel caps included. Better than any Plössl!

FOCAL LENGTH	EYE RELIEF	APPARENT FIELD
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7.5mm – 1.25"	5mm	51°
12.5mm – 1.25"	9mm	51°
18mm–1.25"	13mm	51°
24mm–1.25"	18mm	51°
30mm–1.25"	21mm	50°
35mm–1.25"	25mm	49°
42mm–1.25"	32mm	36°
45mm–2"	32mm	50°
60mm–2"	39mm	45°
80mm–2"	50mm	34°

Ultima Eyepiece Series

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Deluxe Zoom Eyepiece – 1.25"

Tripod – Alt-Az Photo Mount

TRIPOD – ALT-AZ PHOTO MOUNT

This tripod mount serves as a super heavy duty photo tripod for cameras with large telephoto lenses, spotting scopes or binoculars. This unit can also be used for small telescope owners who want to upgrade their mounts. It comes with two slow motion cables, adjustable wood tripod and with a ¼ x 20 photo head.

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The new Ultima Series Barlow (2X – 1.25") is an air-spaced, three-element apochromatic design with a 27mm clear aperture. It is a super high quality design and **fully** multi-coated. It is amazingly short (2.75") and weighs just 5 oz.

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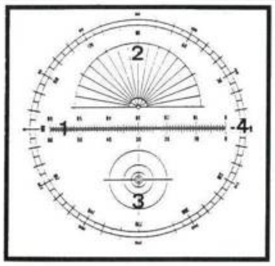
The Micro Guide Eyepiece is totally free of internal reflections and with sufficient eye relief that the reticle can easily be viewed even with eyeglasses. Its finely laser etched micrometer scale has graduations 50 microns apart and 15 microns wide. It includes: eyepiece, built-in cordless battery holder with adjustable brightness control, batteries, instructions.



Micro Guide Reticle

Micro Guide Eyepiece

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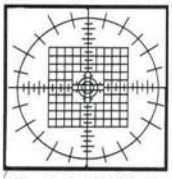
The second finest in the world!

This Orthoscopic guiding eyepiece has a very fine laser-etched reticle with concentric guiding patterns similar to that of the Micro Guide Eyepiece plus conventional cross hairs. At 50 microns, the central square is the smallest and most sensitive for guiding in the industry. With the 6mm ocular, the reticle can be moved about without moving the eyepiece, making the acquisition of a guide star easier. Features include: an illuminated reticle and adjustable brightness control.
Batteries are included.


6mm Illuminated Reticle Pattern

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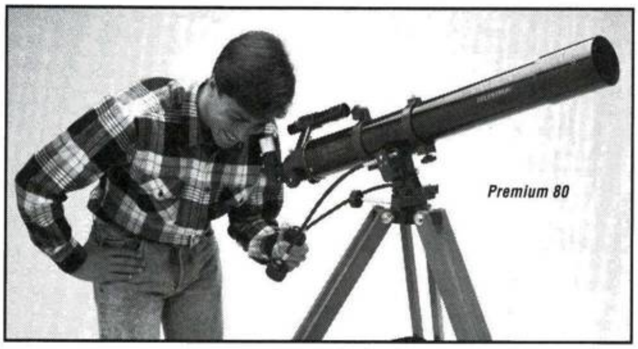
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Starlight Memories

by William H. Waller

On my tenth birthday, my parents presented me with a telescoping spyglass. Its three nested tubes were made of nubby black cardboard, with the largest tube sporting a 1.5-inch objective lens and shiny brass cowl. Depending on the arrangement of the lenses in the eyepiece tube, I could get magnifications of 25, 50, or 75. Thrilled by this long-anticipated gift, I eagerly waited for night to fall so I could scope out the stars.

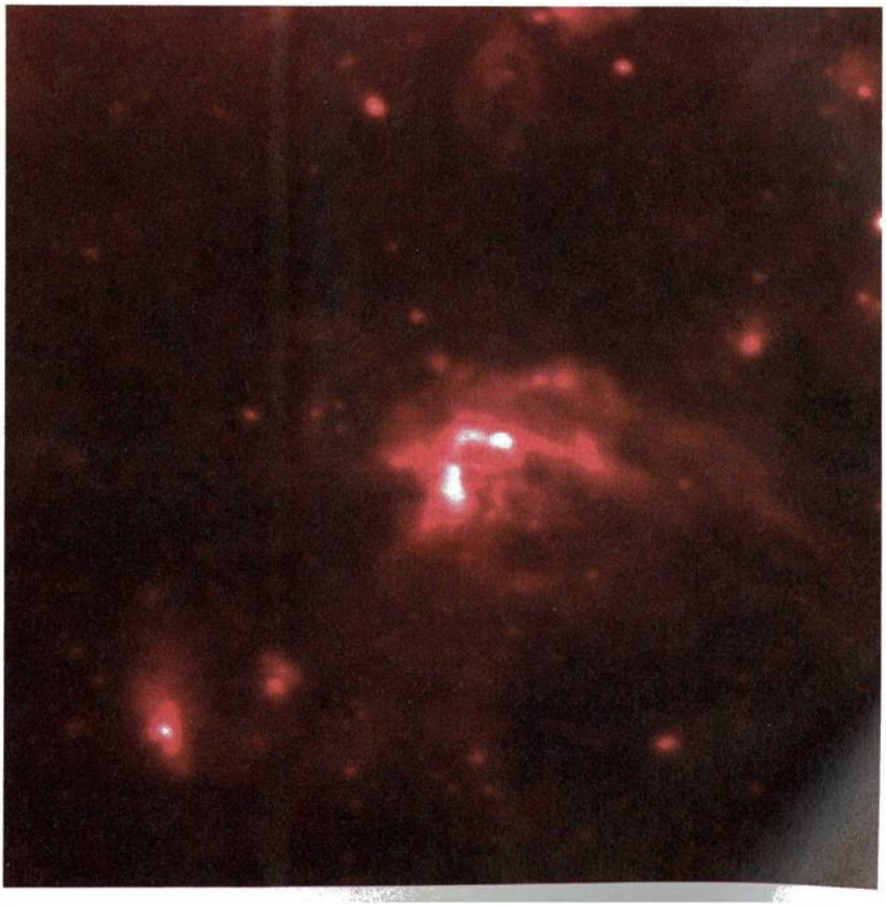
That November evening in Rockport, Massachusetts, turned out to be a New England classic. An early snowstorm had passed through the area, leaving behind a foot-thick blanket of dense snow and a jet black sky filled with sparkling stars. After dinner, I hastily went outside in my bathrobe and slippers, padding over the squeaky snow in search of a good site to make my first astronomical observations.

By wedging my spyglass between two fenceposts, I could aim it at a conveniently located bright star. Perhaps it was Vega, but I don't remember. What I do recall is the magnified image of that star. My shaky view through the eyepiece revealed an enormous ball of variegated and rapidly transforming hues. I was awestruck.

It wasn't until several weeks later that I realized I had been viewing the stars without properly focusing the telescope. After getting some practice focusing on the waxing Moon, I now saw the stars reduced to trembling points of intense light. Although disappointed by my telescope's inability to reveal any structure in the stars, I was also dazzled by the intensities and incredible distances implied by these unresolvable suns. From that moment on, I was hooked.

Some three decades later, I am now one of hundreds of astronomers vying for time on the Hubble Space Telescope.

THE GIANT EMISSION NEBULA NGC 595 in Galaxy M33 photographed in H-alpha from Kitt Peak in Arizona.



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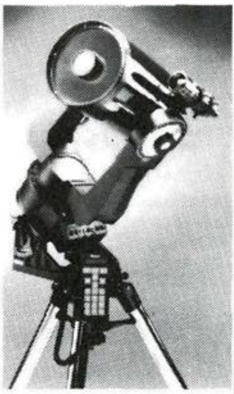

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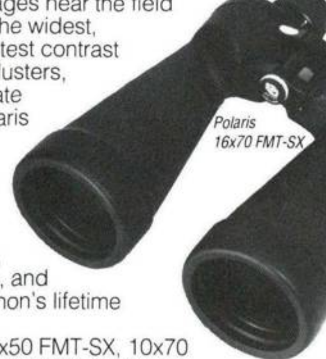

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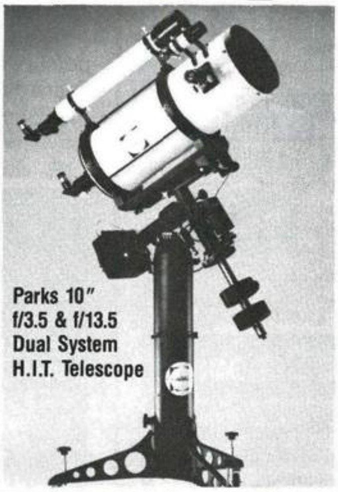
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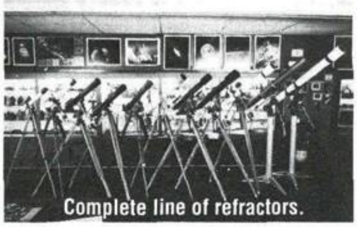
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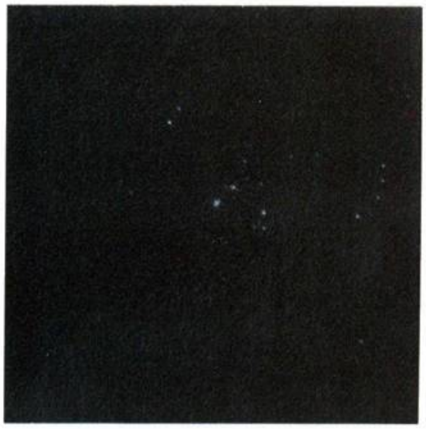
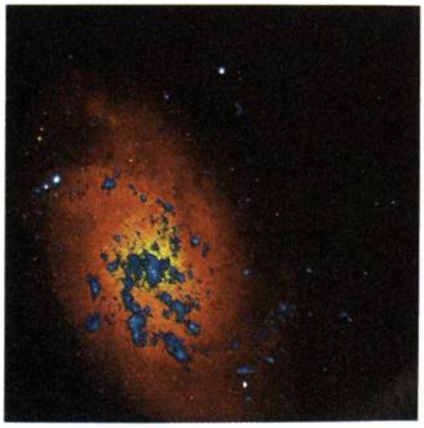

William H. Waller, NASA GSFC and STScI

HUBBLE'S VIEW OF NGC 595, made with the Wide Field and Planetary Camera 2, cleanly resolves the massive stars that power the glowing gas.

For four years in a row, my collaborators and I have joined the fray, submitting proposals to image giant emission nebulae in the Pinwheel Galaxy, M33 in Triangulum. Our first three attempts were turned down. But on the fourth try, our refined justification for the project, an expanded list of co-investigators, and a new set of reviewers combined to give our project a passing grade. We were fortunate to make all our observations this past year, which allowed us to achieve our goal.

For the first set of images, I made a point of traveling to Baltimore and the Space Telescope Science Institute to see the controllers sending commands to the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FALSE-COLOR BLUE highlights the emission nebulae in M33 in this image made with the Ultraviolet Imaging Telescope. NGC 595 is the blue-white knot closest to the center of the image.

Hubble Telescope as it slewed onto our targets and began taking exposures. Several hours later, the data tape onboard Hubble "played back" our tape along with those of other observations made during a 12-hour period. The data traveled to a TDRSS communications satellite, which relayed it to a station on the ground and ultimately to the basement in the Institute, where I waited.

My first view of our data on the computer screen unleashed panic. All I could see were miniscule flecks on the displayed image. After initial computer processing to remove the cosmic ray hits, only a small smattering of tiny flecks remained. Had we missed the mark?

Images from the ground and even earlier Hubble images taken before its mirror was fixed had led me to envision rich clusters of splashy stars underlying the giant emission nebulae. Yet the new images revealed little more than widely separated pinpricks of light. It was only after I got back home and compared the images to those taken before that I confirmed we had hit our target squarely.

Once again, I had been fooled! The repaired telescope's incredible resolving power had transformed a packed field of blurry stars into a desert of irreducible points. Just as I had with my first spyglass, I felt dismay over the visually barren scene and at the same time was amazed at the power of those pointlike beacons. To illuminate emission nebulae measuring hundreds of light-years across, these powerful stars must each hold dozens of times the mass of the Sun and radiate the energy of a million suns, mostly in the scorching ultraviolet. With Hubble's acute vision, I could now sense their awesome significance.

Several months have now passed since I received my first images from the refurbished Hubble. Each picture shows a similar scene in a different part of the Pinwheel Galaxy. About 10 of these giant emission nebulae inhabit the Pinwheel, an impressive number for such a modest spiral.

My goal is to understand the properties of the stars that power these nebulae so that we might interpret bursts of star formation in galaxies much further away. More personally, I find myself simply marveling at the starlight, just as I did when a shivering boy in slippers and bathrobe more than 30 years ago. ☐

William H. Waller is an astronomer at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

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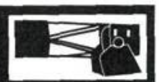

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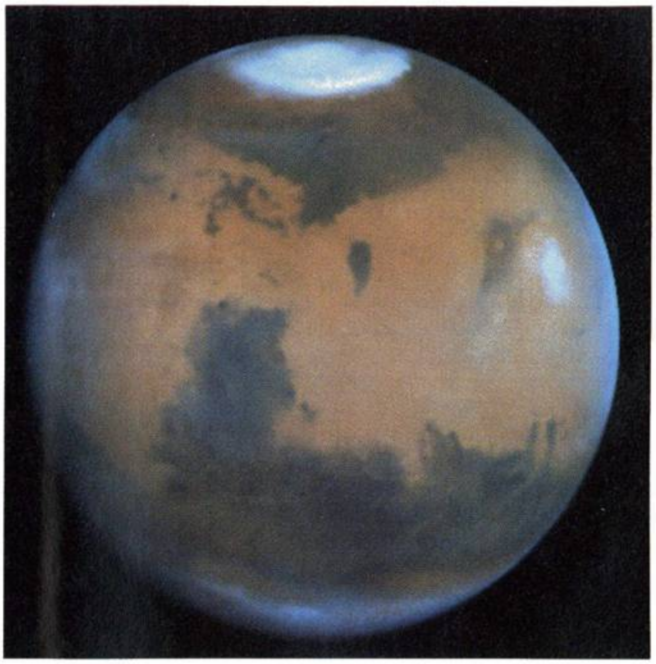
Mars in Hubblevision

If a picture's worth a thousand words, then scientists using the Hubble space telescope must be feeling like verbal millionaires. A team led by Phil James (University of Toledo) used the orbiting observatory to take these fantastic images of Mars during its recent opposition. The pictures boast a resolution of 25 kilometers (15 miles) per pixel and are surpassed in quality only by photos returned almost 20 years ago by the Viking orbiters.

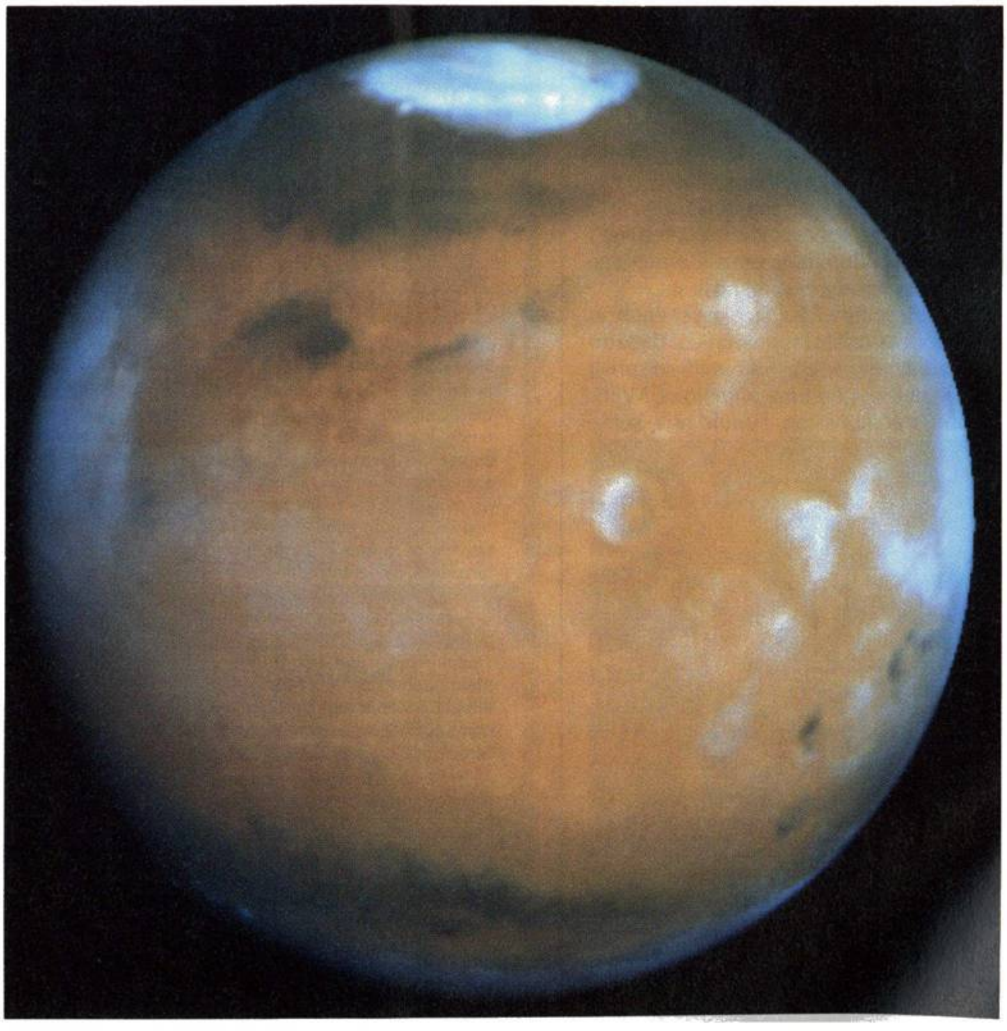
"We're resolving Martian volcanoes right down to their calderas [central craters]," says team member Jim Bell of NASA' Ames Research Center. "We also see obvious lanes, gaps and irregularities in the north polar cap."

Bell and company followed the cap's evolution since August using Hubble and speculate that its shrinking contributed to a plethora of clouds that brush the face of Mars. And there's still more cloud activity: morning hazes on the east (left side) of the planet, plus clouds that form against giant volcanoes.

The team, which includes Steve Lee and R. Todd Clancy of the University of Colorado and Leonard Martin of the Lowell Observatory, plans to monitor Mars' atmosphere through August, hoping to catch a dust storm or two.



DELTA-SHAPED Syrtis Major dominates this February 24th image. Blue mists mark the morning side of Mars and white afternoon clouds mark evening. Close to the evening limb is a large circular haze around the volcano Elysium. Exposures taken through colored filters with Hubble's WF/PC II were combined to make this color picture.



BRIGHT, RUDDY DESERTS command this view taken February 25. Near the evening limb are four large volcanoes with clouds on their slopes. The largest is Olympus Mons; careful scrutiny reveals its inner crater, the caldera.

Steve Lee and Mike Wolf, (University of Colorado); Jim Bell, NASA Ames

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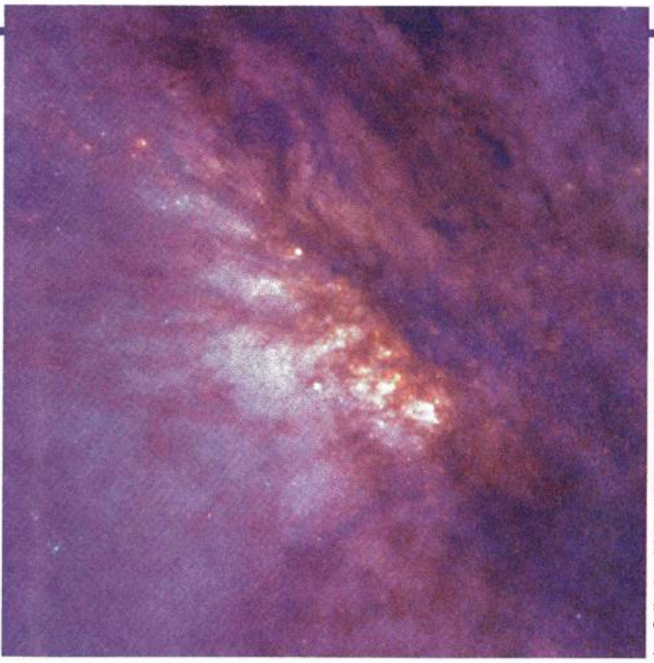
Hubble Images Star Birth and Star Death

Two dramatic new images made with the Hubble Space Telescope's Wide Field and Planetary Camera 2 depict the rapid-fire births of stars in the core of a nearby galaxy and the gaseous remains left in the wake of a star's explosive death.

Hubble's high-resolution image of the Veil Nebula in Cygnus (below) reveals the three-dimensional structure of intertwined strands of gas. The Veil Nebula formed 15,000 years ago when a massive star exploded, leaving behind a slowly expanding shell of gas. The supernova's blast wave has recently hit a dense cloud of molecular gas, creating a shock front that excites the expanding gas and causes it to glow.

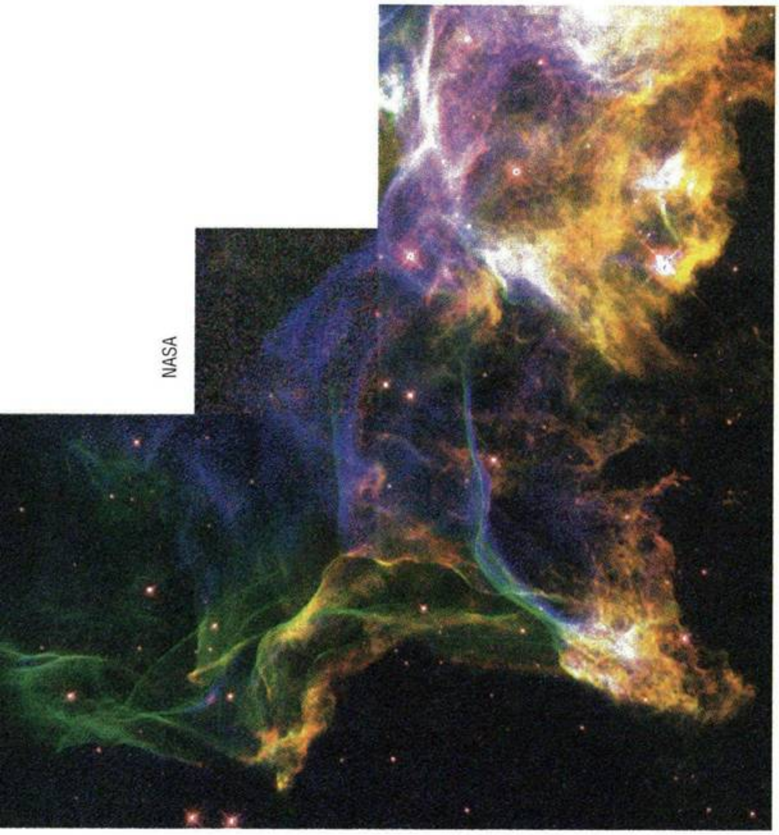
Hubble caught young stars by imaging the violently active center of the galaxy NGC 253 in Sculptor (right), an Sb-type spiral located 11 million light-years away. NGC 253 is the nearest starburst galaxy, which means it is undergoing a flurry of star formation. The Hubble image shows the central 1,000 light-years of the galaxy and reveals small, bright clumps of new stars. One of these near the center of the image is a superbright compact star cluster.

For the first time the Hubble image shows complex structures inside a starburst galaxy including dust lanes that trace regions of dense gas and filaments of glowing gas. Astronomers don't yet know in all cases what causes bursts of star formation to occur in galaxies. Likely culprits? Encounters with other galaxies, colliding gas clouds inside galaxies, and central black holes.



Jay Gallagher (Univ. of Wisconsin), NASA

THE CORE OF STARBURST GALAXY NGC 253 appears in a new Hubble Space Telescope image (top). The region represents a tiny portion of the center of the galaxy's disk (above).



NASA

TWISTED STRANDS OF GAS comprise the Veil Nebula, a supernova remnant imaged by Hubble. The slowly-expanding nebula formed when a star exploded 15,000 years ago.

Ghost Particle Sculpts the Universe

Every second, billions of neutrinos pass unimpeded through each square centimeter of Earth. Now researchers at the Los Alamos National Laboratory have announced that these ghostly particles have a slight mass. This finding raises the possibility that neutrinos constitute a portion of the dark matter that makes up at least 90 percent of the universe and play a fundamental role in sculpting the cosmos. (See "Shedding Light on Dark Matter," February 1992.)

Physicists used to think that the neutrino possessed no mass, but to explain various unresolved problems in astronomy and physics, some theorists over the past twenty years have suggested it might have a small mass. The problem: measuring the mass of a particle that rarely interacts with matter. The Los Alamos team created a shower of just one type of neutrino and found that some of the group changed into a second type, a process that theory says would require the neutrino to have mass.

The results give a mass for the neutrino of between 0.5 and 5 electron volts, between a millionth and a hundred-thousandth of the mass of another minuscule particle, the electron.

But there are so many neutrinos, roughly a billion of them for every electron and proton in the universe, that their total mass is enormous. At 5 electron volts, they would constitute 20

"...one small step for a man, one giant leap for mankind"

—JULY 20, 1969

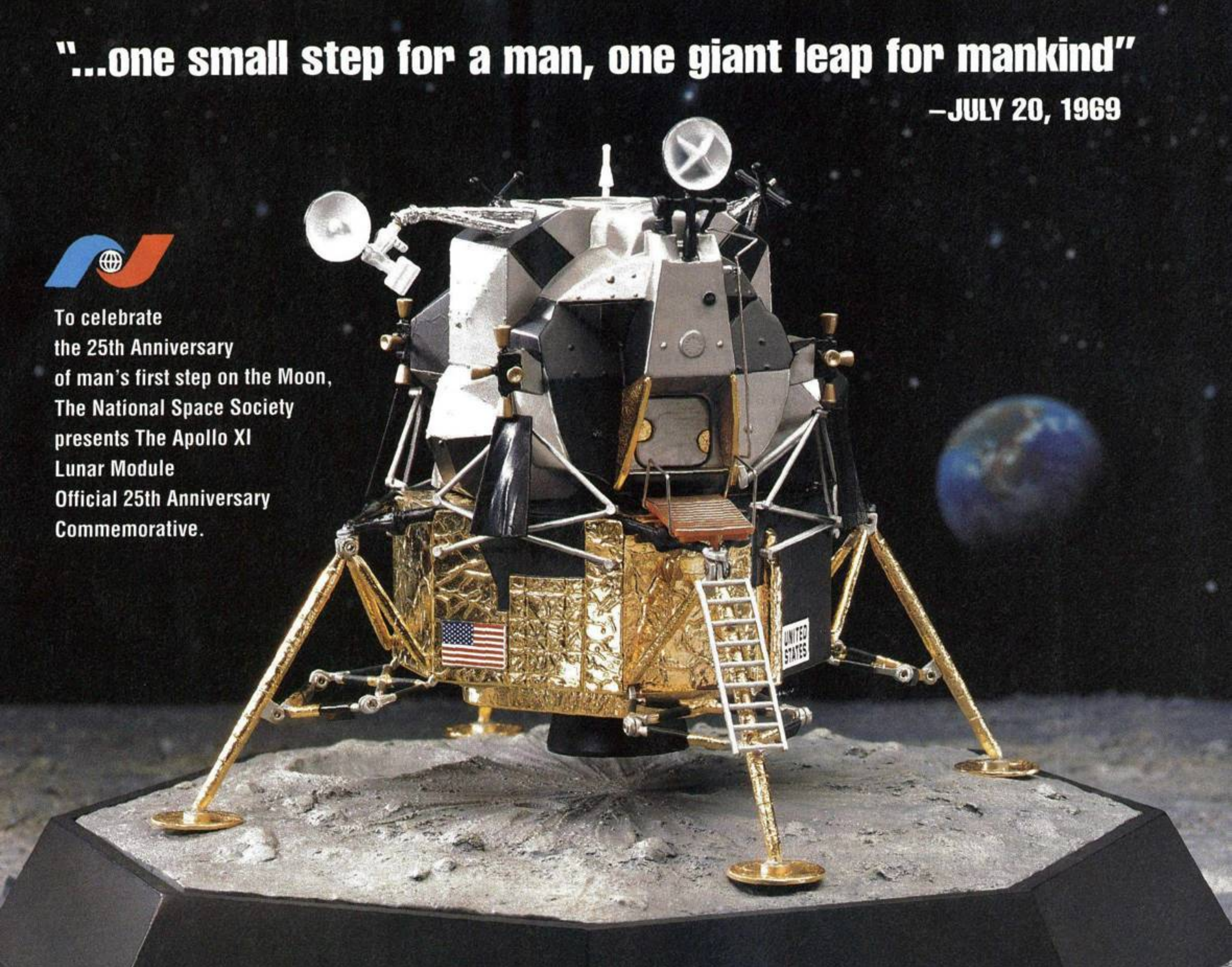


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PHOTO COURTESY OF NASA.

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percent of the universe's mass.

Neutrinos fall into the category of hot dark matter, particles that move close to the speed of light. Until recently, astronomers thought that slower-moving cold dark matter made up most of the unseen mass in the universe. But recent studies show that a mixture of both hot and cold is needed to make the universe look precisely as it does now.

If this new finding holds up, neutrinos could turn out to be the hot dark matter that theorists need to fully understand the evolution of the universe.

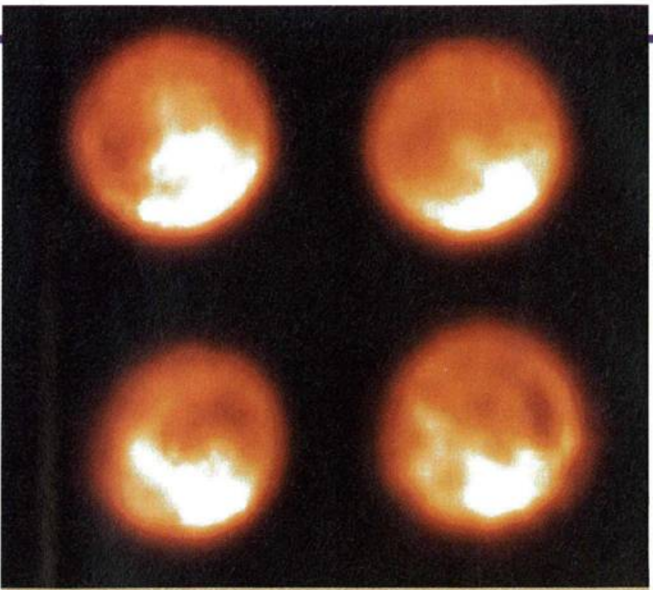
Pulsar's Neon Implies White Dwarf Origin

A team of astronomers from the United States and Japan has discovered strong neon emission from the X-ray pulsar 4U 1626–67, a binary star system located roughly 20,000 light-years away in the constellation Triangulum Australe.

The finding shows that 4U 1626–67 contains at least five times more neon than the Sun does. This implies that the pulsar's companion is the core of an evolved star that was once much bigger and currently produces neon as a by-product of helium burning.

This in turn suggests that the pulsar formed from the collapse of a white dwarf that accumulated too much mass from that bloated companion star and not directly from a high-mass star as most pulsars do.

The researchers detected the neon with Japan's Advanced Satellite for Cosmology and Astrophysics. Lorella Angelini of the



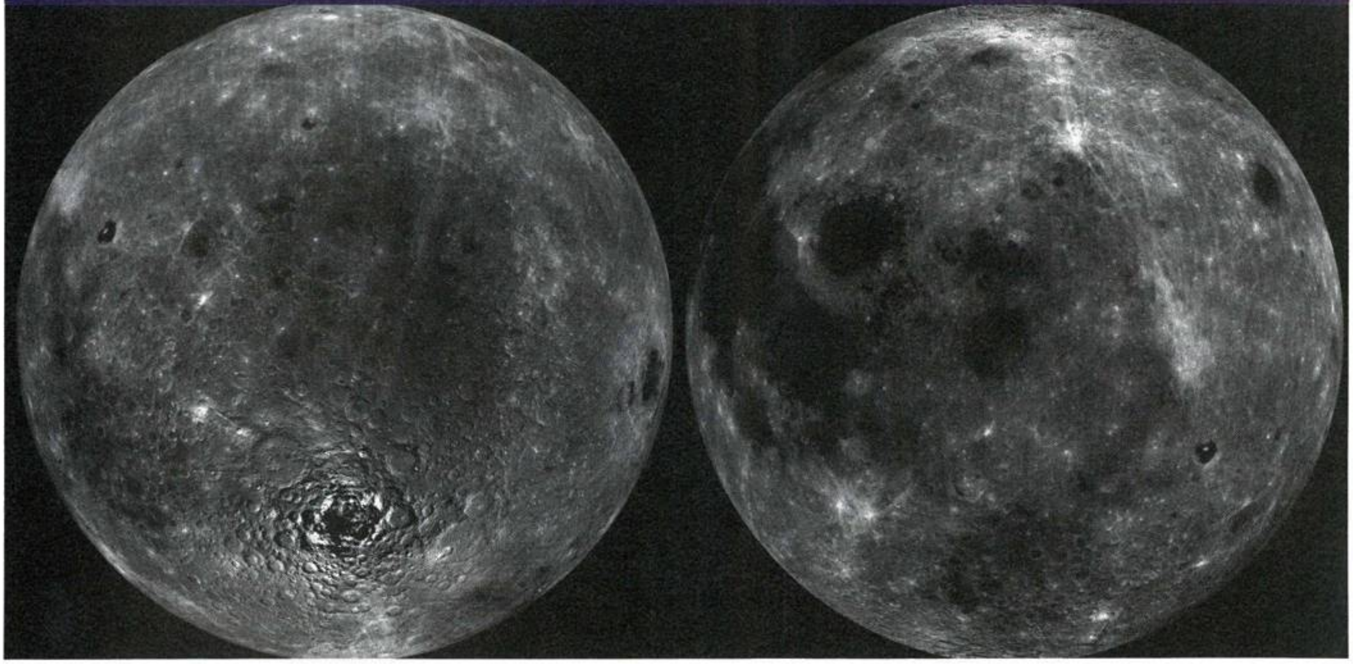
François Roddier, University of Hawaii Institute for Astronomy

TITAN'S SURFACE GLOWS EERILY in this series of near-infrared images made with the Canada-France-Hawaii Telescope on Mauna Kea, Hawaii, using an adaptive optics system. A bright, continent-sized feature on this largest moon of Saturn stands out at bottom right of each image. The near-infrared wavelength penetrates the smog-laden atmosphere of Titan, allowing astronomers to peer through to the surface. Earlier images made with the Hubble Space Telescope first revealed the bright surface feature (see "Hubble Maps Titan's Hidden Landscape," February 1995). The top two images were made on December 23, 1994, and show Titan as seen through a K filter (left) and an H filter. The bottom pair of images were taken a day earlier.

New Faces of the Moon

LIKE A HUGE BLACK EYE, the South Pole-Aitken impact basin marks the lunar farside (left). Over 8 kilometers deep, the basin is a relic of the Moon's early history.

The brightest crater below is Giordano Bruno, among the Moon's youngest. (Both photos are new mosaics of Clementine images at 1 km per pixel resolution.)



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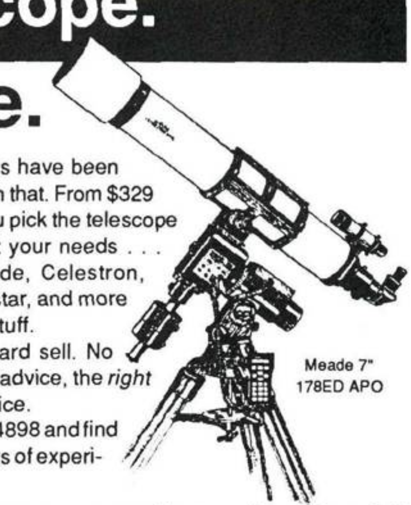

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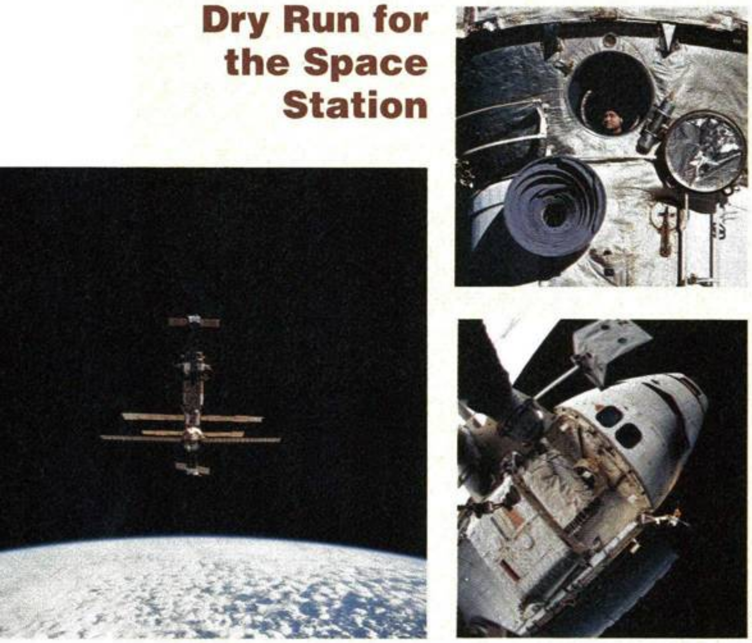
NASA/Goddard Space Flight Center and University Space Research Association announced the findings at the January meeting of the American Astronomical Society in Tucson, Arizona.

4U 1626–67 is a binary star consisting of a neutron star pulsing X rays every seven seconds and a faint blue companion star burning helium. The two orbit each other every 41 minutes, which indicates that they are separated by about the same distance as the Moon and Earth, or only some 30 percent the diameter of the Sun. The X-ray emission means that the neutron star must possess a strong magnetic field and have formed less than 10 million years ago. But the stars in 4U 1626–67 are too close together for one of them to have recently been a high-mass supergiant star that collapsed to form a neutron star.

The astronomers conclude that the neutron star was a white dwarf that collected enough mass from its companion to push it over the 1.4-solar-mass limit for those stars. The helium-burning companion is most likely the remnant core of a much more massive star in a much bigger binary system. As it aged, the star expanded and eventually engulfed the white dwarf. The gas slowed the white dwarf's orbital motion and it spiraled into the star's interior. Before it reached the core, however, the hot white dwarf radiated enough energy to eject most of the outer envelope. The white dwarf could have collapsed into a neutron star either while it was spiraling in or after the system settled down.

Dry Run for the Space Station



NASA

DISCOVERY APPROACHES MIR, the Russian space station, during February's rendezvous in space (above, left). The spacecraft tested procedures that will be needed when the shuttle Atlantis docks with Mir this month. During the rendezvous, cosmonaut Valery Polyakov looks out Mir's window (top, right). Polyakov has been on board since January 1994, setting a record for the longest spaceflight. Shuttle astronaut C. Michael Foale surveys Discovery's cargo bay and forward section (above, right) during his spacewalk. The spacewalk's main purpose was to get the astronauts very cold to determine what changes need to be made in spacesuits before assembly of the space station begins.

AMATEUR NEWS

Universe '95 Approaches

JOIN THE FUN AT UNIVERSE '95 on June 24 and 25 in College Park, Maryland. The meeting, sponsored by the Astronomical Society of the Pacific and ASTRONOMY magazine, features a star party, a tour of NASA's Goddard Space Flight Center, and displays of telescopes and observing accessories, astronomical posters, books, and software. The photo below shows a few of the exhibits from UNIVERSE '94, held in Flagstaff, Arizona.

Speaking to this year's expected crowd of over 1,000 astronomy enthusiasts will be professional astronomers Laura Danly (galaxies), Eric Feigelson (the young Sun), Margaret Geller (structure in the universe), Heidi Hammel (Comet Shoemaker-Levy 9 impacts on Jupiter), David Helfand (supernovae), Anne Kinney (quasars), Charles Lada (star formation), Lucy-Ann McFadden (comets and asteroids), Vera Rubin (expansion of the universe), Harry Shipman (evolution of stars), Stephen Strom (formation of stars and planetary systems), amateur astronomers Glenn Gombert (infrared imaging) and Jack Newton (astroimaging with CCDs), ASTRONOMY editors Dave Eicher (deep-sky observing) and John Shibley (telescopes), plus many others. For more information, contact UNIVERSE '95, ASP, 390 Ashton Avenue, San Francisco, CA 94112 or call (415) 337-1100.

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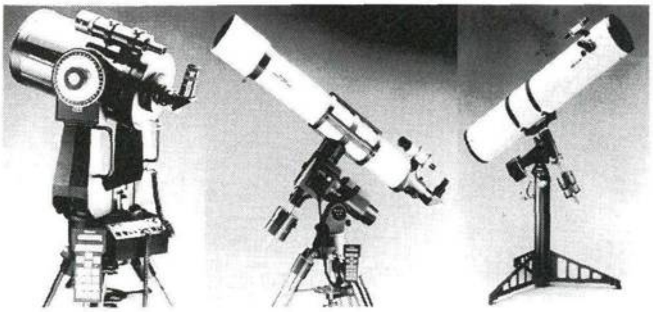

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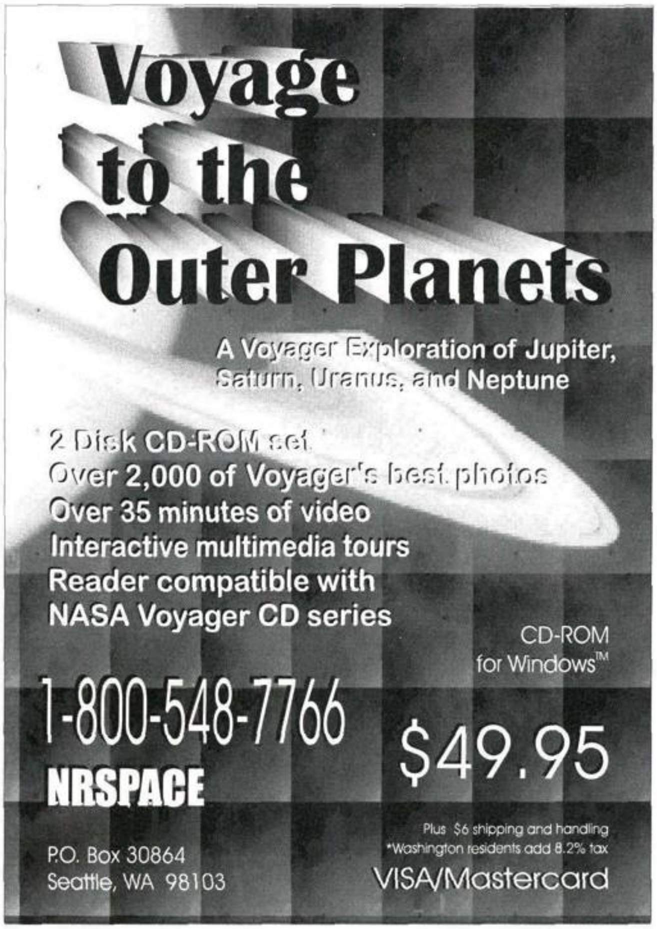

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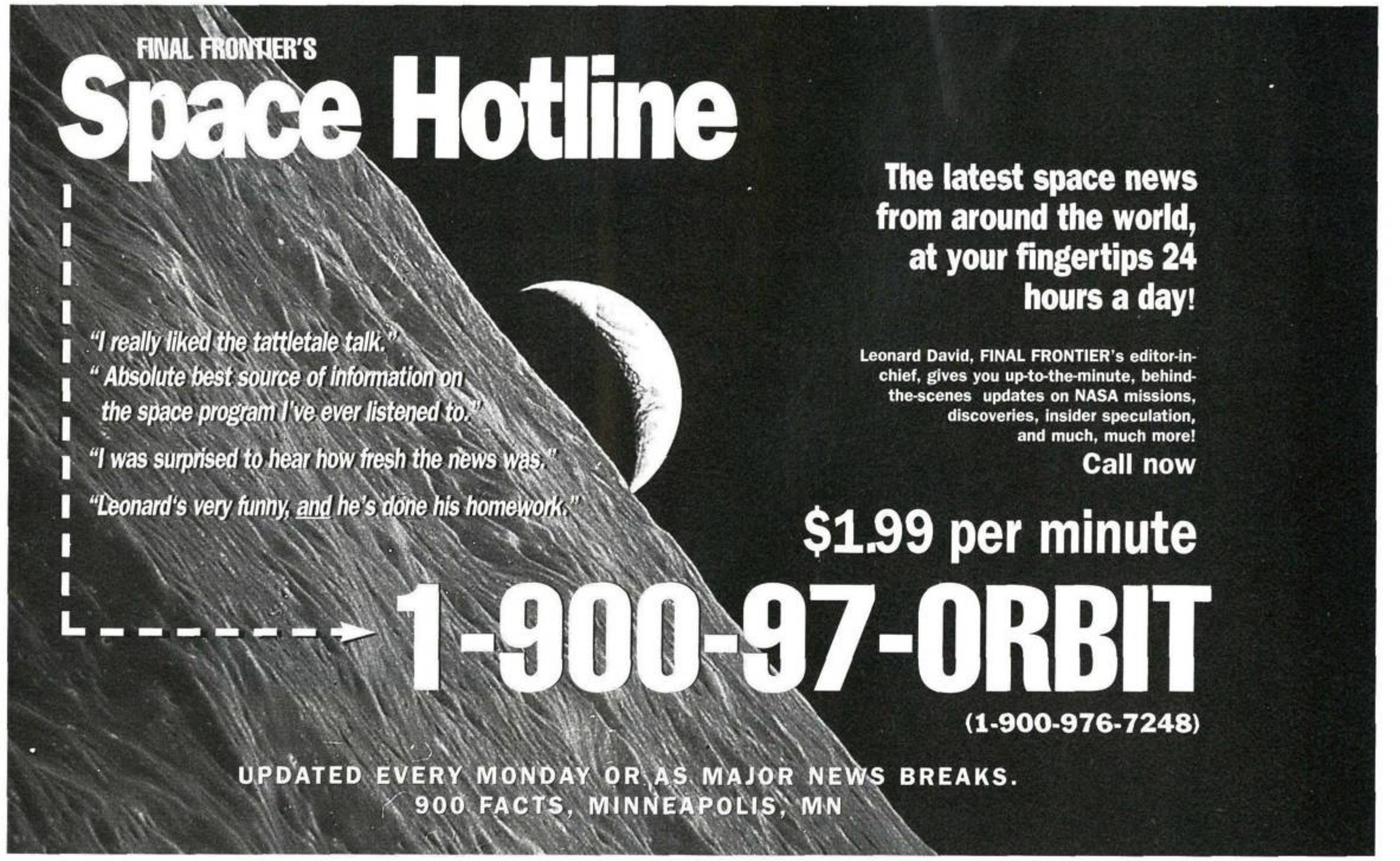

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Dark Matter Abounds in Dwarf Galaxy

Astronomers have long suspected that dark matter, the material composing most of the universe, envelops galaxies and clusters of galaxies in tenuous shrouds. Now a team of researchers using the W.M. Keck Telescope in Hawaii has also found strong evidence of dark matter in a far smaller object, a dwarf galaxy orbiting the Milky Way.

Steven Vogt and Michael Keane of the University of California at Santa Cruz, Mario Mateo of the University of Michigan, and Edward Olszewski of the University of Arizona's Steward Observatory studied the motions of individual stars in the galaxy Leo II. The rapid motions of the stars led the team to conclude that Leo II contains about six times as much dark matter as the bright matter astronomers see with optical telescopes. Without the gravitational pull of the invisible mass, stars moving that quickly would escape the galaxy entirely.

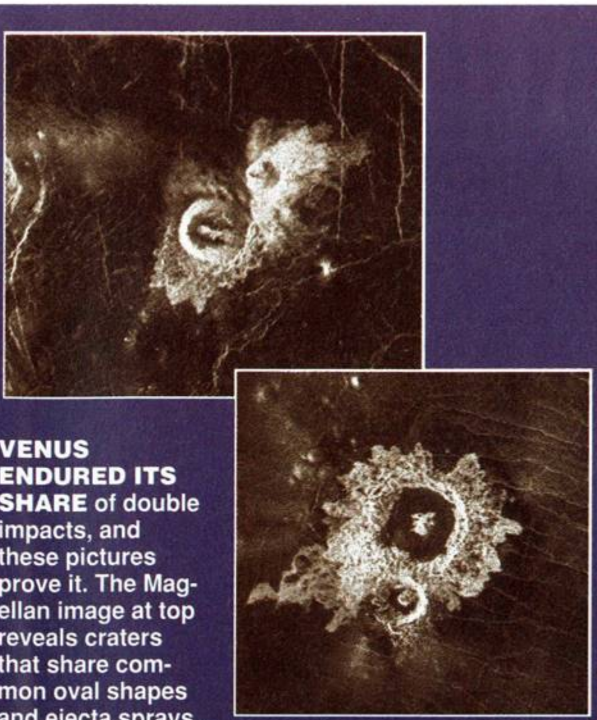
"The result has significant implications for cosmology," says Vogt. "Dwarfs are among the most common galaxies. If they all contain dark matter, they may contribute an unexpectedly large amount of total mass to the universe."

The study, which appeared in the January 1995 *Astronomical Journal*, presented spectra of stars within Leo II, which lies 720,000 light-years away. Shifts in the spectra toward the blue or red end of the spectrum indicate motion toward or away from Earth. Many such observations yield a picture of the speed and direction of motion in this swarm of stars.

Olszewski cautions against quick judgments. "With only one dwarf spheroidal galaxy you can always find ways to wiggle out of dark matter," he says. "With knowledge of each additional system, wiggling becomes harder. Leo II provides a very clean test of the dark matter hypothesis for dwarf spheroidals."

DWARF GALAXY LEO I, like its twin Leo II, contains a loose collection of stars. Astronomers found that Leo II has six times more dark matter than visible matter. Such discoveries of dark matter in small objects like dwarf galaxies may ultimately account for much of the "missing mass" in the universe.

David Malin, Anglo-Australian Observatory



VENUS ENDURED ITS SHARE of double impacts, and these pictures prove it. The Magellan image at top reveals craters that share common oval shapes and ejecta sprays, indicating two asteroids hit simultaneously. Still another suspected doublet (right) shows uncluttered crater floors. Scientists reason that if one had hit earlier, it would have scattered debris on the other's floor.

H J. Melosh, LPL

Two by Two, Part II

Telltale double craters on the Earth and Moon point to the existence of double asteroids (see "Two by Two They Came," December 1994). Now researchers have found that Venus harbors its own record of double impacts.

At a Venus conference held in Tucson last January, Cheryl Cook, Jay Melosh, and William Bottke, all of the Lunar and Planetary Laboratory, presented results of a crater survey they conducted using Magellan radar data. After examining all crater pairs separated by 90 miles or less, they found 29 probable doublet craters. Furthermore, an examination of multiple craters with diameters of greater than 6 miles turned up 13 suspected double craters. If these craters indeed formed from common objects, the proportion of double craters to all craters on Venus is 4.4 percent. After factoring in the odds that chance pairings might masquerade as doublets, that number drops to 2.5 percent.

This percentage is significantly less than what is found on the Earth and Moon. Why? Perhaps, the investigators say, Earth statistics are skewed because of the few impact features remaining on Earth's active surface. Another possibility is that Venus' dense atmosphere stops smaller double asteroids, thus reducing the number of double craters. At the very least, the team says, the finding bolsters the notion that Earth- and Venus-crossing double asteroids exist. □

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M1 Crab Nebula. *This expanding gas cloud is the brightest known supernova remnant in the sky. At an estimated distance of 6300 light years it is expanding at 600 miles per second, or some 50 million miles per day, which is one of the highest velocities known in the Galaxy. At the center of this nebula is a remarkably tiny neutron star, probably not more than a few miles in diameter, and with an extremely strong magnetic field, rotating at the astonishing rate of 30 times per second. Sixteen minute ST-5 CCD image taken through a Celestron Ultima 8 at f/6.3 and guided off-axis. Courtesy Jim Riffle, Astro Works West, Arizona.*

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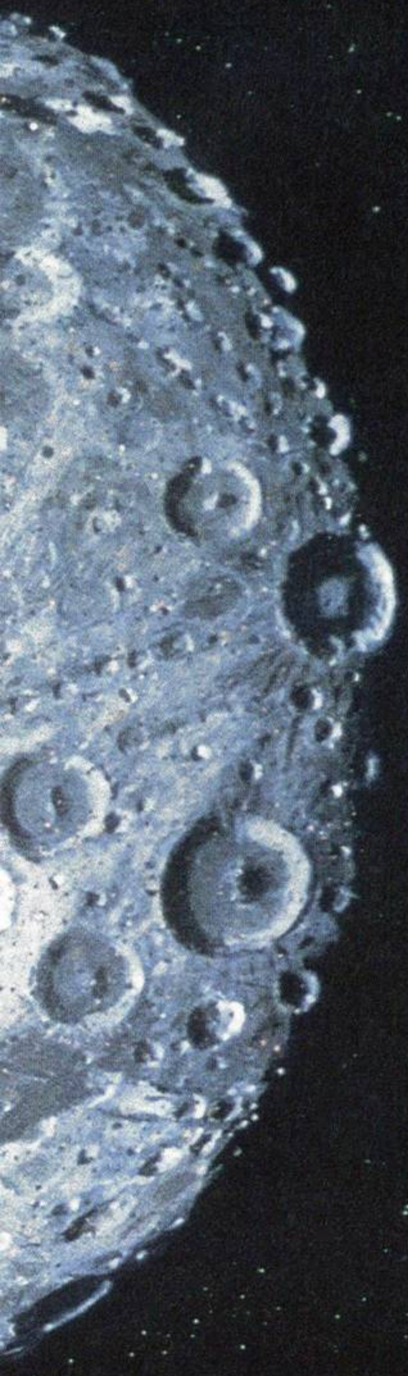
The Sun's Fab Four



For almost 200 years the four large minor planets Ceres, Pallas, Juno, and Vesta were nothing more than tiny points of light in a telescope eyepiece. Today, thanks in part to new results from the Hubble Space Telescope, they are becoming worlds unto themselves.

by Alan Stern

Ben Zellner, Georgia Southern University

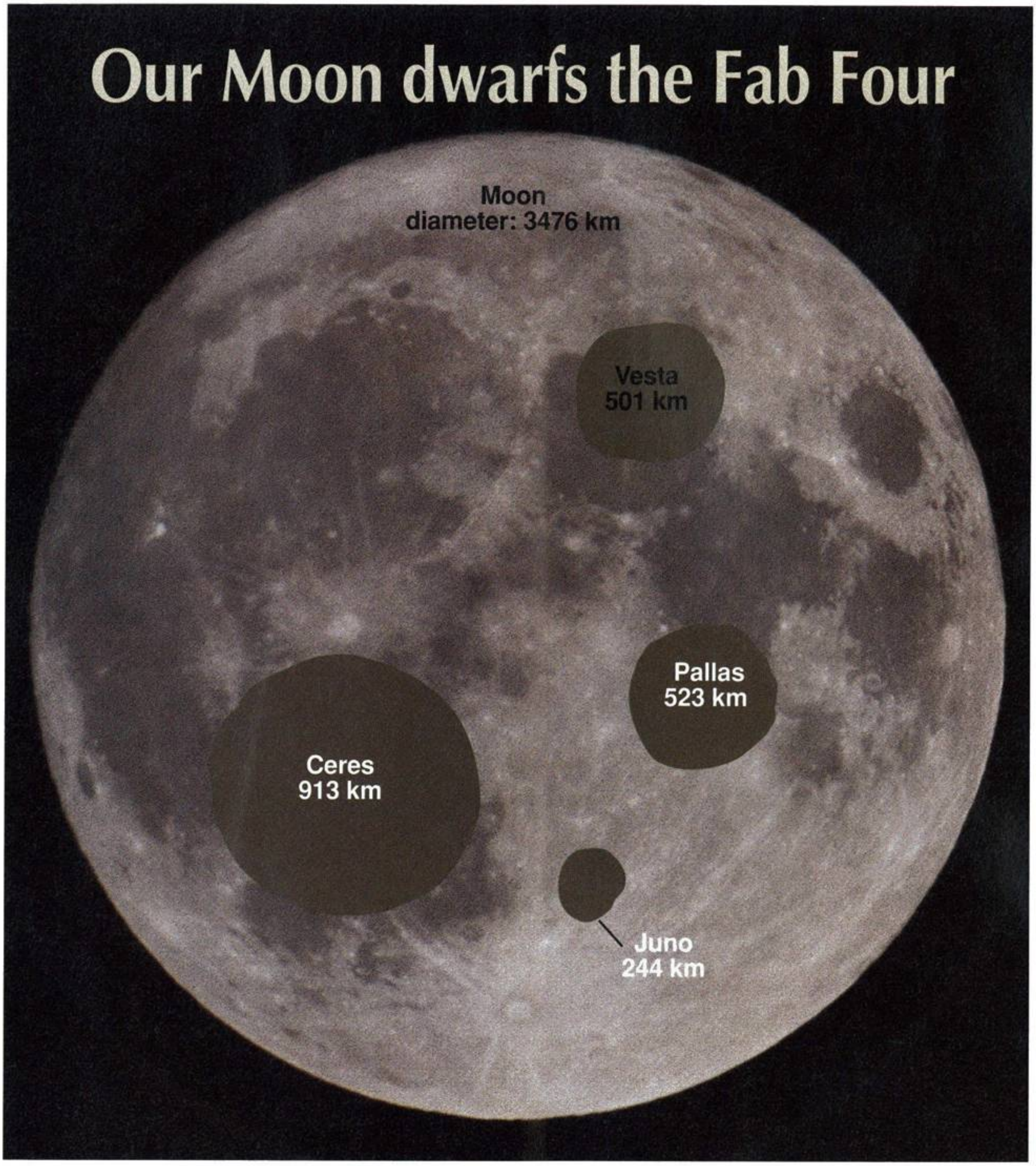
The soft-edged, lopsided object glows feebly in this blurry inset photo from HST. Its features are indistinct. This could almost be the Moon as seen by the naked eye, but it isn't. The object is Vesta, a 500-kilometer-diameter ball of rock circling the Sun halfway to Jupiter.

The new Hubble photo hints at what's remarkable about Vesta: Those light and dark areas may correspond to areas like the highlands and maria on the Moon. If true, that would give Vesta a kind of evolutionary history scientists once thought only full-sized planets had.

Nor is Vesta alone. It is but one of perhaps a million small, rocky bodies that orbit the Sun between Mars and Jupiter. Thousands more lie inside the orbit of Mars, while another set orbit along with Jupiter. These bodies, collectively called the asteroids, are so numerous they were once called "the vermin of the skies." Given their numbers, it's

Vesta painting: William K. Hartmann, Planetary Science Institute

Our Moon dwarfs the Fab Four



no surprise that the tiniest asteroids captured the lion's share of asteroid studies. However, scattered among these Lilliputian tribes lie a few giants, worlds that truly deserve the term *minor planet*. Vesta is one such, as are its cousins Ceres, Pallas, and Juno. And these larger bodies are now coming into their own as worlds to study.

Two streams of solar system research converge in the asteroid belt. The older arose from classical astronomy and seeks to understand the origin of the planets. The second, a child of the space age, is using the latest telescopes and techniques to delve into the individual histories of these bodies. Where the two streams intersect, scientists are at last unfolding a marvelously rich and detailed view of the solar system.

Asteroids were not always scorned as vermin. In fact, in 1801 when astronomer Giuseppe Piazzi discovered the first, which he named Ceres, it neatly filled an embarrassing gap. Astronomers had noticed the big jump between the orbits of Mars and Jupiter and had postulated a missing planet to fill the space. Ceres' orbit fit well.

Then in 1802, Heinrich Olbers discovered a second, fainter object orbiting between Mars and Jupiter; he named it Pallas. Confronted with two objects to fill the gap, astronomers' thoughts shifted from missing planets to shattered ones. Could the original missing planet have somehow broken apart, they wondered? This seemed confirmed as intensified searches for additional

Visualizing Vesta

Vesta's surface is so unlike that of any other asteroid, it's been placed into a class of its own. Not surprisingly, this uniqueness makes it a rather attractive target for many astronomers. Last fall, Ben Zellner of Georgia Southern University used the Hubble Space Telescope's Wide Field and Planetary Camera 2 to take pictures of Vesta as it completed one rotation. The images show much of Vesta's surface to a resolution of 70 km or better. (The unaided eye reveals a similar view of the Moon.) In them we see bright and dark features temptingly similar to regions on our Moon. This leads to the intriguing possibility that geologists may one day have a smaller cousin to our Moon to study and compare.

And that day may be not be far off. A proposal made by Cornell University's Joseph Veverka, NASA's Jet Propulsion Laboratory, and Martin Marietta Aerospace puts forth an unmanned mission to Vesta arriving in 2003. Imaging cameras would map areas of its surface to 10 meters, with some on-board instruments "tasting" the asteroid's chemical composition from a 250 km orbit. (See diagram on page 37.)

What exactly makes Vesta so interesting?

For one thing, of all the large asteroids, Vesta has the most reflective surface. Its average visible-wavelength albedo, or efficiency at reflecting light, is 38 percent. Compared to the Moon's average albedo of 7 percent, Vesta is brilliant. In fact, even though at Vesta's distance sunlight is reduced to just 15 percent of the strength experienced on Earth, an astronaut on its surface would see a scene about as bright as on Earth's Moon. And the similarity wouldn't end there.

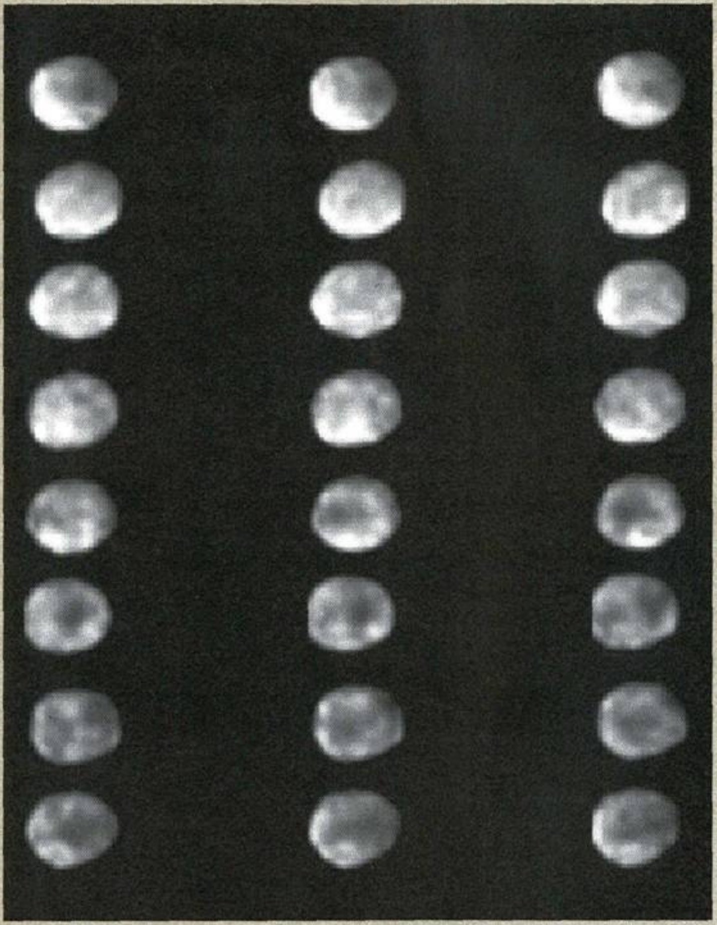
Like areas on the Moon humans have seen, Vesta's surface is covered in a fine, pulverized powder about 6 centimeters deep. Vesta is also composed of volcanic basalts created when its surface was melted, perhaps by some nearly catastrophic collision early in its history.

Vesta's intriguing characteristics led it to become one of the first asteroids compositionally fingerprinted. Over 20 years ago, Tom McCord (now at the University of Hawaii) developed a method called reflectance spectroscopy that uses light broken down into its component colors. With the technique, McCord accurately determined Vesta's mineral content.

Similar observations pioneered by Michael Gaffey of Rensselaer Polytechnic Institute, along with recent images taken by Hubble, reveal other features analogous to lunar maria. Some of these regions have minerals called pyroxenes and feldspars, typically found in the Earth's mantle. Perhaps craters punched through Vesta's basaltic crust to excavate material from its upper mantle.

Complementing this picture are actual pieces of Vesta believed to have have fallen to Earth as meteorites called basaltic achondrites. Careful work by astronomers like Richard Binzel of MIT reveal the way these chips off Vesta came to Earth.

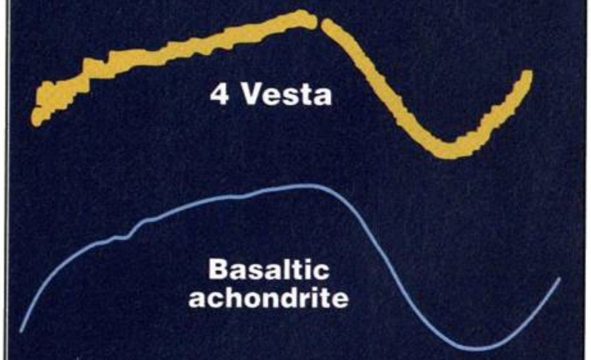
A string of tiny meteoroids blasted off Vesta fell into orbits susceptible to the influences of Jupiter's gravity, which then perturbed them into Earth-crossing orbits. As a result, these basaltic achondrites, which have reflectance spectra identical to the spectra of Vesta, fall to Earth on a regular basis. Whether this debris found its way to Earth via Jovian resonances or was blasted directly off Vesta's crust is uncertain. It's likely that both channels make the Vesta-to-Earth meteorite conveyor work.



Ben Zellner, Georgia Southern University

VESTA'S SHATTERED SURFACE shows up in these images taken by the Hubble Space Telescope last fall. The dark splotches might be pools of hardened lava or evidence of huge impacts that punched through Vesta's crust into a darker mantle. The images, shot over four days in 1994, show one complete rotation of Vesta.

Evidence we have pieces of Vesta . . .



Visible-light spectra of Vesta and basaltic achondrite meteorites collected on Earth are virtually identical.

Richard P. Binzel

bodies turned up Juno in 1804, Vesta in 1807, and Astraea in 1845. All lay within the gap between Mars and Jupiter.

But the pace of discovery was slow when astronomers worked at the telescope only by eye. With the advent of astronomical photography in the late 19th century, the discovery rate shot upward and hasn't slowed since. Planetary scientists have now cataloged more than 6,000 asteroids, and they estimate that between 100,000 and 1,000,000 additional bodies (with diameters between 1 km and about 40 km) remain to be found.

Such numbers can overwhelm. But from them a general picture of the asteroid belt has taken shape, and some curious features emerge. Interestingly, the belt isn't just a random mix of bodies; instead, it's stratified according to distance from the Sun. For example, the inner one-third of the belt has mainly asteroids with surfaces that are relatively reflective, somewhat reddish, and rich in iron-bearing minerals. The outer two-thirds of the belt is dominated by darker asteroids that resemble carbonaceous chondrite meteorites. Less populous classes also exist, including at least one believed to derive from Vesta itself. These objects appear to be covered in basaltic lava. This is the hallmark of planetary evolution and a telltale sign that whatever Vesta is, it is not geologically simple.

Asteroid statistics point out another anomaly. The total mass in the asteroid belt is surprisingly small — only about a tenth the mass of Earth's Moon. Moreover, of all the mass of asteroids a kilometer or larger in size, fully 40 percent reside in just the "Fab Four" — Ceres, Pallas, Juno, and Vesta — alone. Ceres, Pallas, and Vesta are also the only asteroids with diameters larger than 500 km. These, the very largest asteroids, form a clearly distinct class that seems to have "broken away" from the general asteroid population. How could this have occured?

To answer this question, planetary scientists first recognize that the present-day population of the asteroid belt is the result of both nature and nurture — that is, the population results from the belt's origin and its later evolution.

Three processes shaped the sizes of asteroids: growth through collisions among bodies that encounter one another at low enough speeds to combine; erosion (or catastrophic shattering) that occurs when bodies collide at high speeds; and orbital changes primarily forced by the gravity of massive Jupiter, lying just beyond the outer edge of the belt.

As with the formation of the planets themselves, asteroids grew initially in a bottom-up process: larger bodies came from smaller ones. The critical factor is that average collision speeds were low enough that collisions mainly resulted in growth, rather than destruction.

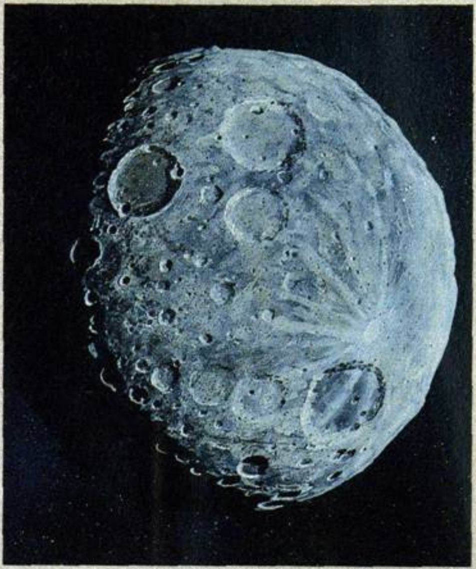
So far, so good. What complicates the process (and makes it more interesting) is Jupiter. This giant planet profoundly influenced the belt in two ways. First, Jupiter's gravitational stirring made asteroid orbits more eccentric. This sped up impact velocities so that most collisions produced fragmentation rather than growth. In fact, computer models of asteroid belt evolution indicate that essentially all the bodies smaller than about 350 km in diameter are the result of catastrophic, high-speed collisions, and that they are significantly younger than the age of the solar system.

Second, Jupiter's influence also created some special regions in the asteroid belt called resonances. These amplify the effects of gravitational perturbations: In some resonances, orbits become unstable; as a result, bodies can be ejected from the asteroid belt.

CHIPS OFF THE OLD ASTEROID? Meteorites like this basaltic achondrite have spectra that not only match spectra taken of Vesta, but resemble terrestrial and lunar basalt lavas.

Russell Kempton, New England Meteoritical Services

Close-up on Ceres



William K. Hartmann, Planetary Science Institute

The solar system's largest asteroid may be more like a planet than an asteroid: Its shape is spherical, and like Mars, this ruddy-colored minor planet might harbor water at its poles.

An astronaut orbiting Ceres would see a yellowish or perhaps slightly orange-tinged surface pockmarked and battered by craters. Studies made from Earth suggest the surface might be clay-like, consisting of soil that has water chemically locked into it and minerals similar to those found in meteorites called carbonaceous chondrites.

Groundbased evidence also indicates it's unlikely our astronaut would see dramatic differences in Ceres' surface color, save at the minor planet's poles. Several tantalizing lines of evidence point to the possibility that Ceres' poles may harbor a cache of frozen water, either mixed in the planet's clay-like soil or, perhaps, lying encrusted on the surface in frozen ponds as a patchy veneer.

While the evidence for water ice on Ceres is not definitive, it is highly suggestive. Larry Lebofsky of the University of Arizona and his colleagues have repeatedly identified the distinctive spectral fingerprint of water ice. Others, including Michael A'Hearn of the University of Maryland and Paul Feldman of Johns Hopkins University, have found evidence for hydroxide (OH), the most common product of water vapor (H_2O), above Ceres' surface.

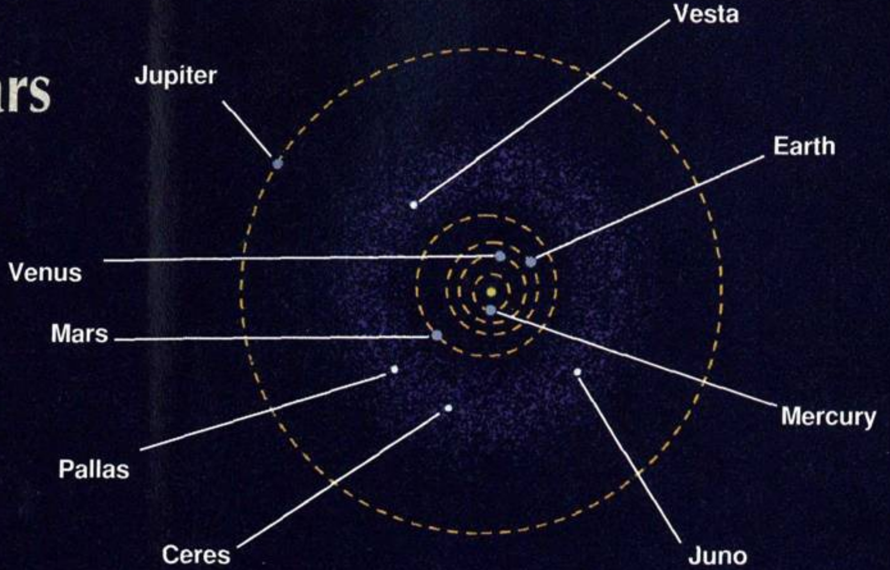
These and other findings have led to studies of the stability of water ice on Ceres. In the most complete study to date, modelers Fraser Fanale and James Salvail of the University of Hawaii believe that water frost would be stable just under, and perhaps even on, the cool surfaces of Ceres' poles. For no other asteroid is the possibility of water ice on its surface known to be so strong.

Moving in orbit around Ceres, an astronaut would notice its surface reflects less light than the lunar highlands — by almost 40 percent, and he might confirm groundbased radar and thermal measurements that indicate a thin, powdery surface overlies a much deeper, more compact layer.

Several orbits later, our astronaut would quickly come to the conclusion that change comes to Ceres only over a long time and through random meteorite impacts and incessant bombardment from cosmic rays, sunlight, and solar wind. We can only speculate what weathered vistas of mountains, rilles, valleys, or scarps might greet a visitor to Ceres. Our still-growing databank isn't very large.

Most asteroids lie between Mars and Jupiter

A view from above the solar system shows the relative positions of the asteroids and planets out to Jupiter.

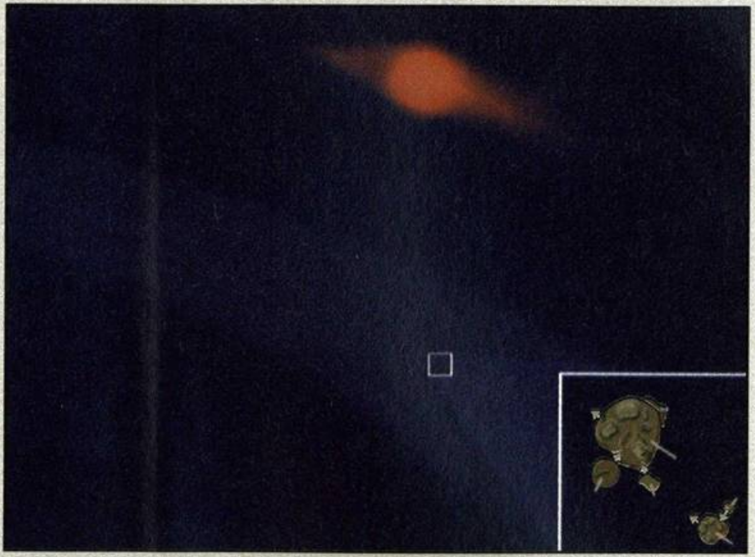


Richard P. Binzel

Three steps to shaping the Asteroid Belt . . .

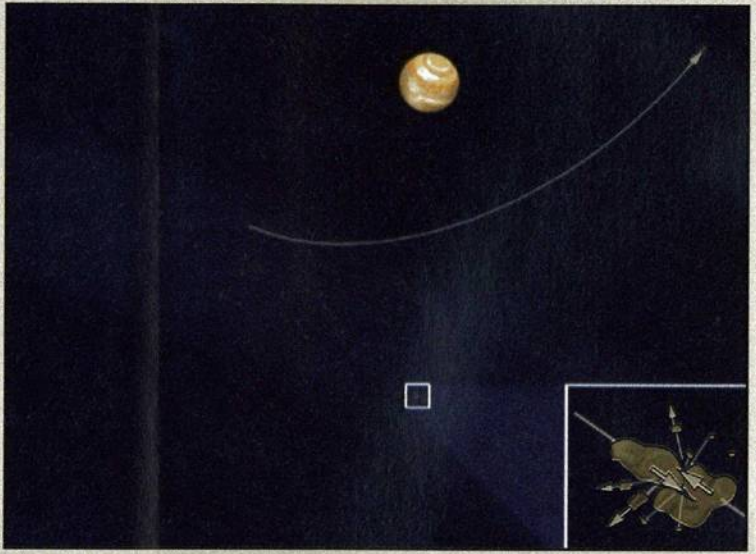
JUPITER IS TAKING SHAPE

- The early Asteroid Belt is full of slow-moving chunks of rock and ice.
- Because their speed is so slow, when these small pieces collide they stick together to form larger asteroids.
- The early Belt forms many asteroids that are Vesta-sized or larger.



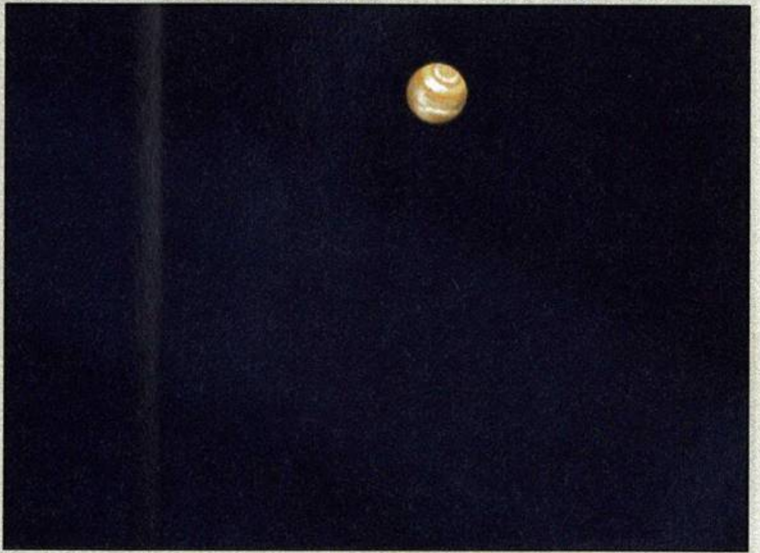
A FULLY FORMED JUPITER WIELDS ITS GRAVITY

- Jupiter's gravity causes asteroids to speed up so when collisions take place, the asteroids don't stick together, but shatter.
- Asteroids in certain areas of the Belt called resonance zones have their orbits modified by Jupiter. In some cases the asteroids are ejected from our solar system altogether.

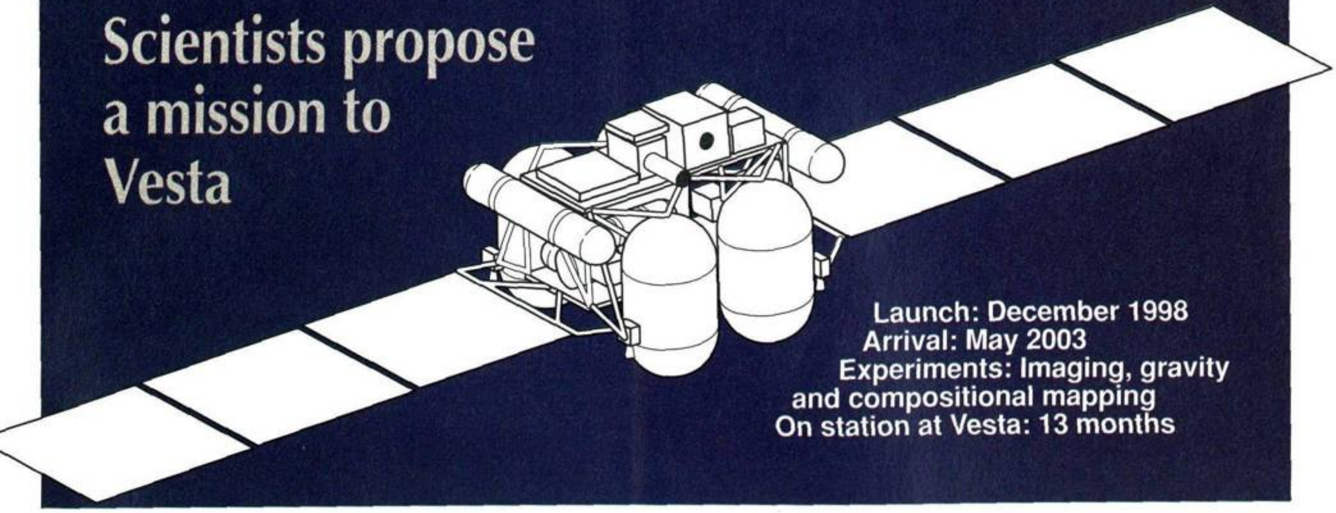


TODAY'S JUPITER LOOKS DOWN ON ITS HANDIWORK

- We see a depleted belt with only a handful of large asteroids among a myriad of shattered, smaller ones.
- Some asteroids have become moons of the outer planets. Others now occupy orbits that take them into the inner solar system past Earth.



Scientists propose a mission to Vesta



Launch: December 1998
Arrival: May 2003
Experiments: Imaging, gravity and compositional mapping
On station at Vesta: 13 months

That *Other* Fab Four

There's another Fab Four among the asteroids even more appropriately named than Ceres, Pallas, Juno, and Vesta. You guessed it — the four made up of 4147 Lennon, 4148 McCartney, 4149 Harrison, and 4150 Starr. Lowell Observatory astronomer Brian Skiff discovered all but one of the celestial Beatles; 4148 McCartney was found by colleague Ted Bowell. The Beatles' namesakes orbit in the main belt and are each about 8 to 10 kilometers in diameter. (Just think, compared with Ceres, Pallas, Juno, and Vesta, this Fab Four was discovered only *Yesterday*. . . .)

Jack Wisdom of the Massachusetts Institute of Technology showed in the early 1980s that this mechanism delivers many meteorites and some asteroids into Earth-crossing orbits.

More recently, George Wetherill of the Carnegie Institution in Washington, D.C., has uncovered a subtle interplay between collisions, gravitational perturbations, and Jovian orbit resonances that deeply affected the early evolution of the asteroid belt.

In his simulations, Wetherill found that collisions can nudge objects into resonances so efficiently that most of the bodies in the early asteroid belt were probably removed, primarily through ejection into Jupiter-crossing orbits. As the asteroid belt cleared out, collisions became infrequent, as they are today. With fewer and fewer objects nudged into unstable resonances, the rate of ejection decreased. Scientists find Wetherill's model attractive because it offers a natural explanation for the meager total mass of the asteroid belt.

Wetherill's results also imply that in its early days, the asteroid belt may have formed more objects in the Vesta to Ceres size-class. Most of these mega-bodies were probably ejected from the belt to suffer collisions with Jupiter or were tossed out of the solar system by it. Thus it would seem that Ceres, Pallas, Juno, and Vesta grew large by accreting smaller objects in low-speed collisions, perhaps just as the belt was clearing out. Then, thanks to their size — and having escaped perturbation into unstable resonances — they survived to the present.

In the billions of years that have rolled by while these four objects orbited the Sun, little has changed on them. They have no detectable atmospheres. Few have satellites. And their surfaces remain today as they have been since they cooled after formation — cold! — with temperatures of –100° C (about 170 K) being typical.

Yes, some of their myriad brethren have bashed and battered them. Yes, solar radiation and cosmic rays have weathered their surfaces. And yes, their orbits have moved around a bit as collisions and perturbations worked their subtle synergy.

But with so little to change them, the Fab Four have remained almost-timeless relics of a distant past. This cannot be said for the terrestrial planets, which have evolved greatly from their formative state. Nor can it be said for most of the objects in today's asteroid belt, which are simple shards left from collisions that occurred only yesterday, considering the age of the solar system. Of all those million-plus objects in the belt, just a handful — namely those larger than about 350 km in diameter — have survived largely intact since the early days of the solar system.

As four of the solar system's largest asteroids, Ceres, Pallas, Juno, and Vesta preserve a bit of the past that is otherwise mostly lost. Scientists look to these roundish little worlds on the frosty border between the inner and outer solar system in hopes that they will one day become scientific beachheads, perhaps even staging points, for the long jump humans will ultimately take across the cold, yawning vacuum to Jupiter. □

Alan Stern is a planetary scientist and the manager of the Southwest Research Institute's research group in Boulder, Colorado.

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40mm Wide-Field Test, "Astronomy," Aug. 1990, p. 90

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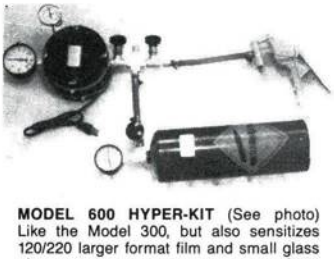

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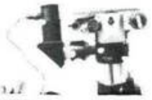

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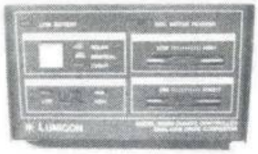

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LX100 - includes wedge, best for photography.
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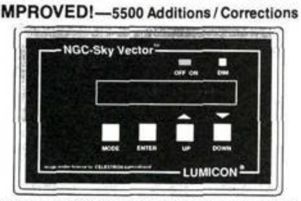

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**Threaded to hold 48mm filters.*

A GALAXY OF NEWS

Miniature spiral galaxies, unclothed quasars, and galaxies in voids: These are just some of the latest surprises uncovered by space- and ground-based observatories.

by David Bruning

The Hubble Space Telescope continues to give astronomers images with unprecedented detail. Some of these images are furnishing new views of familiar galaxies, such as the Cartwheel Galaxy. Others are providing pictures contrary to those researchers expected for objects such as quasars. Not to be outdone, radio and optical astronomers have used their ground-based scopes to supply some new insights into a supermassive black hole at the center of a galaxy, dwarf spiral galaxies, and the future of the universe.

Among the astronomers presenting these results at the January meeting of the American Astronomical Society in Tucson, Arizona, was Kirk Borne of the Space Telescope Science Institute in Baltimore, Maryland. In October 1994, his team of researchers took the image on the opposite page of the Cartwheel Galaxy in the constellation Sculptor. They used the Wide Field and Planetary Camera 2 to look at the ring that gives the Cartwheel its name. The ring formed when an intruder galaxy (one of the two small galaxies in the image) smashed through the once-normal spiral galaxy and is so large that the Milky Way Galaxy would fit inside.

What the new Hubble image shows are the details of star formation in both the ring and in the galaxy's core. Like the ripple created by a pebble dropping into a pond, the expanding ring reveals how gas and dust in the galaxy compressed after the collision. Stars form quickly in the ring and outshine the galaxy's disk, still faintly seen as the "spokes" in the Cartwheel. Knotlike features in the ring are large clusters of newly formed stars. Giant bubbles appear in the ring as well, caused by the supernova explosions of massive stars as they die.

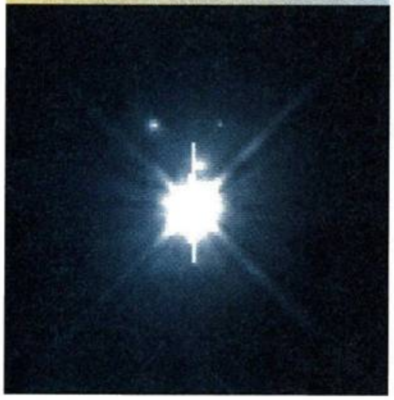
While the image of the Cartwheel gives researchers a chance to study how massive stars form, other Hubble images have created a dilemma about quasars. Astronomers have long suspected that quasars lie at the center of the galaxies. A supermassive black hole lying at the galaxy's core swallows gas from the galaxy and powers the quasar's energetic outpourings. Observers using ground-based telescopes in fact thought they had detected "fuzz" around some quasars, presumably the faint traces of the galaxies surrounding the quasars.

In what John Bahcall of the Institute for Advanced Study in Princeton, New Jersey, called "a giant step backward," Hubble images show that most quasars appear "unclothed." That is, most quasars seem not to have a galaxy around them.

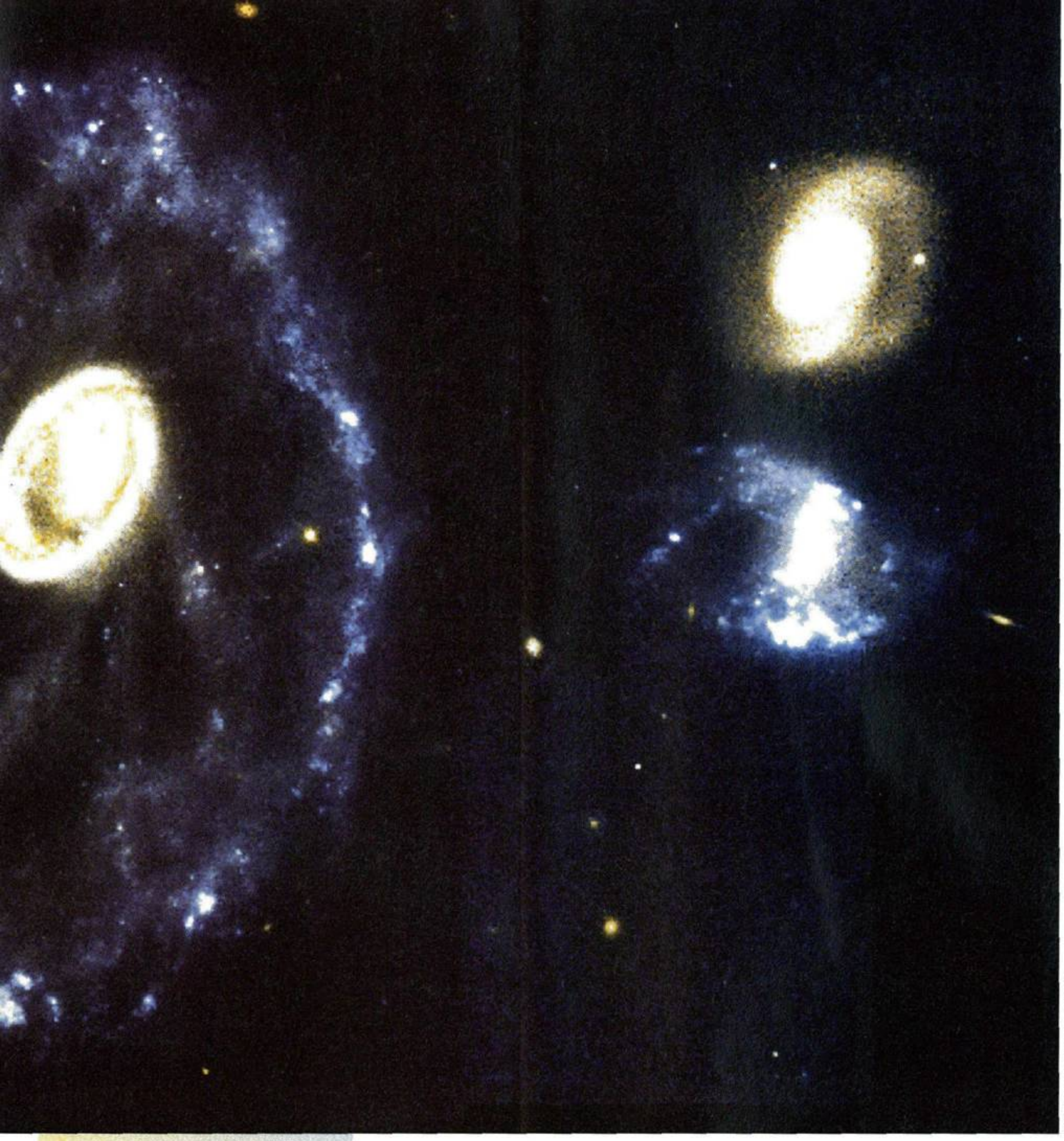
Bahcall, Don Schneider of Penn State, and Sofia Kirhakos of the Institute for Advanced Study have looked at 14 nearby quasars. Ten of the 14 are unclothed. Only two appear in galaxies, one in a spiral and the other in an elliptical galaxy.

The remaining two are colliding with galaxies. That and another clue may be key to solving the new quasar

A GIANT LEAP BACKWARD. Images taken with Hubble's Wide Field and Planetary Camera 2 don't reveal the galaxies that were expected to surround quasars, such as PKS 1302–102 in Virgo shown here. So astronomers now have to rethink their ideas about the relation between quasars and galaxies.

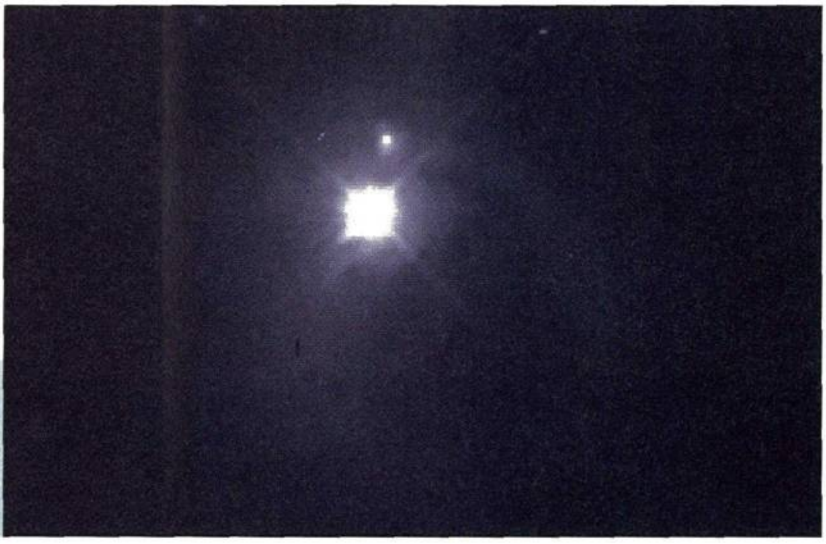


John Bahcall, Inst. for Advanced Study, et al., and NASA



Kirk Borne, STScI, and NASA

A MIGHTY RING of newly formed star clusters outshines the spiral disk of the Cartwheel Galaxy. Hubble's Wide Field and Planetary Camera 2 took this true-color image. One of the two galaxies at right plowed through the Cartwheel, sparking the new star formation.



John Bahcall, Inst. for Advanced Study, et al., and NASA

NO ORDINARY COLLISION: the quasar PKS 2349–014 in Pisces is merging with a galaxy. Hubble's Wide Field and Planetary Camera 2 captured this unexpected merger.

puzzle. The unclothed quasars have companion galaxies that will merge with them in a few million years. Don Schneider says, "We are struggling to understand how our images fit into the general picture of quasar creation and evolution. It is much too early to know what the final conclusions will be. This is the most enigmatic data I have ever analyzed."

Perhaps another clue to understanding the origins of quasars will come from luminous infrared quasars. Wil van Breugel of the Lawrence Livermore National Laboratory in Livermore, California, and Arjun Dey of the University of California at Berkeley have discovered five distant, extremely luminous, and probably young quasars. The objects were first detected more than a decade ago by the Infrared Astronomical Satellite. Van Breugel and Dey identified the quasars using the 3-meter Shane telescope of Lick Observatory on Mount Hamilton near San Jose, California. The quasars lie at least 9 billion light-years away. Each emits more energy than a hundred trillion Suns, or 10,000 Milky Way Galaxies.

Unlike most quasars, these objects are optically faint and emit most of their energy in the infrared. The weak optical emission and strong infrared emission implies dust enshrouds the quasars. Dey suggests, "These quasars are probably just emerging from their cocoons of gas and dust and are still surrounded by the debris from which they formed."

Most quasars appear to have little gas surrounding them. But some galaxy pairs merging together are enshrouded by gas and dust and have luminosities similar to that of quasars. Van Breugel says, "The properties of these newly discovered infrared quasars suggest that they may be the link between ultraluminous merging galaxies and the bright quasars."

The origin of quasars is a small detail compared to the structure and fate of the universe. Quasars and galaxies gather into galaxy clusters, and clusters gather into larger superclusters. These clusters and superclusters don't lie randomly in space but collect along sheets. Because these sheets contain almost all of the matter in the universe, the regions in between the sheets are essentially void of galaxies. The nearest such large region is called the Bootes Void. It lies about 500 million light-years away and has a radius of about 100 million light-years.

But it turns out that the Bootes Void isn't entirely empty of galaxies.

Big Scope Maps Black Hole

Last summer, Hubble found a disk at the center of the elliptical galaxy M87, which lies near the center of the Virgo Cluster (see AstroNews, September 1994). Astronomers believe the disk is material falling into a supermassive black hole. From motions in the disk, they estimate that the black hole's mass is 3 billion times the mass of the Sun. New radio maps with a resolution 1,000 times better than the Hubble images indicate the mass of the black hole is confined to a region less than a few light-weeks across.

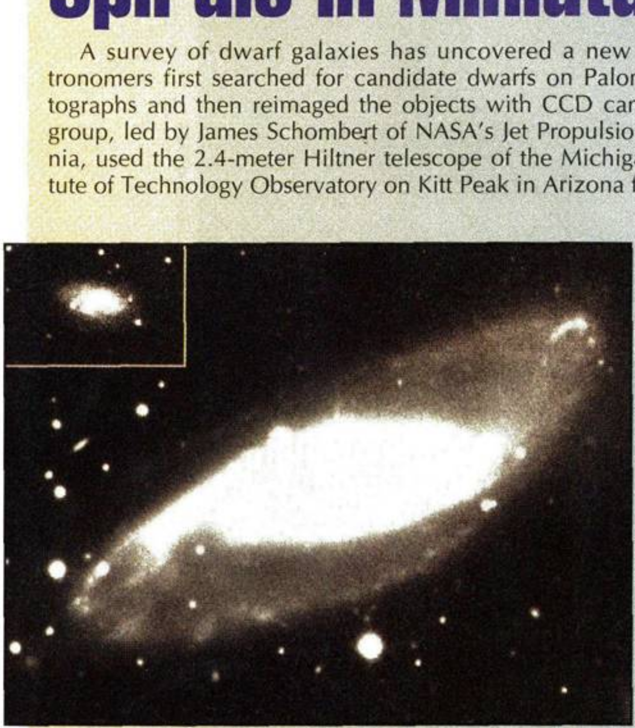
Bill Junor of the University of New Mexico in Albuquerque and John Biretta of the Space Telescope Science Institute in Baltimore, Maryland, combined observations from many radio telescopes in the United States, Italy, Sweden, and Germany, including the Very Large Array in New Mexico and the Very Long Baseline Array (see "Big Ears," August 1994). By combining the signals from all the scopes, they could obtain the resolving power of a telescope nearly the size of Earth. They achieved a resolution of 0.00015", which corresponds to the width of a human hair seen 50 miles away.

Although this supermassive black hole would be 100 times smaller than Junor and Biretta could detect, their resolution rules out virtually every other possible cause of the jet that emanates from M87's core. The new radio maps also show that the jet starts quite close to the black hole. Astronomers thought dense gas in the galaxy formed the jet a few light-years from the black hole. But the maps show it starts a few light-weeks from the black hole. The researchers guess that magnetic fields near the disk surrounding the black hole aid the jet's formation. Magnetic fields wrapped around the jet possibly hold it together over its length of several thousand light-years.

"Our observations have introduced a new puzzle," said Junor. "We find that the speed of the jet is slow close to the black hole. But for material to escape the gravitational clutches of the black hole, it must have a speed close to the speed of light." Gas in the jet far from the black hole has high speed. The researchers suggest that they are seeing slow-moving gas at the jet's edge and that material in the jet's core does move at high speed.

Spirals in Miniature

A survey of dwarf galaxies has uncovered a new class of galaxies. A team of astronomers first searched for candidate dwarfs on Palomar Observatory Sky Survey photographs and then reimaged the objects with CCD cameras to confirm their shape. The group, led by James Schombert of NASA's Jet Propulsion Laboratory in Pasadena, California, used the 2.4-meter Hiltner telescope of the Michigan-Dartmouth-Massachusetts Institute of Technology Observatory on Kitt Peak in Arizona for the reimaging.



Rachel Pildis, Univ. of Michigan

DWARF SPIRAL GALAXIES are a new class of galaxies. The dwarf spiral D564-15 (top left) in Cancer appears here at the same scale as a giant spiral, NGC 536 in Andromeda.

For four decades, astronomers have suspected that dwarf spirals exist because they saw small galaxies with apparent spiral arms. But dwarf irregulars can look like they have spiral arms. So the team used the 300-meter Arecibo radio telescope in Puerto Rico to confirm that the suspected dwarf spirals had disks that rotate. Other types of dwarf galaxies do not rotate.

Measurements of the rotation rates of the galaxies will help the researchers determine the masses of the six dwarf spirals they found. They already have an idea of the size of the dwarf spirals. Normal spirals range in diameter from 20,000 to 1 million light-years; dwarf spirals have diameters as small as 7,000 light-years.

New Galaxy Distance Measurements

A key project being carried out using the Hubble Space Telescope is the measurement of the distances to nearby groups and clusters of galaxies. For the next two to three years, a new galaxy will be observed every two months. The program will establish known distances for 20 carefully selected galaxies to be used in developing techniques for finding the distances to more remote galaxies. The key project will also determine the Hubble constant, which measures the expansion rate of the universe.

Atlas of Galaxies, NASA

Robert Kennicutt, Univ. of Arizona, and NASA

HUBBLE IS SEARCHING for Cepheid variables in 20 galaxies, such as M100 shown here. The inset shows the region observed by Hubble's Wide Field and Planetary Camera 2. Measuring Cepheid brightnesses enables astronomers to find the distance to each galaxy, a crucial step in determining the expansion rate of the universe.

One of the first key-project galaxies measured was the spiral M100 in the Virgo Cluster (see "How Far to Virgo?" March 1995). Researchers used the Wide Field and Planetary Camera 2 to determine the brightnesses of 20 Cepheid variable stars and the periods with which their brightness varies. The period is related to the intrinsic brightness of the star. Comparing this brightness with the brightness measured by Hubble establishes the star's, and thus the galaxy's, distance.

Over 60 Cepheids have now been found in M100. That will help refine the 56 million light-year distance already reported, but by itself it won't greatly improve the project's initial estimate of the Hubble constant, 25 ± 5 kilometers per second per million light-years. For that, the key project team needs to find the distance to more galaxies.

The team already has looked at two more key-project galaxies: M101 in Ursa Major and NGC 925 in Triangulum. Dan Kelson and Garth Illingworth of the University of California at Santa Cruz and their collaborators found 29 Cepheids in M101. From the brightnesses of the Cepheids, the team determined that M101 lies 24 million light-years away.

Nancy Silbermann and Barry Madore of Caltech's Infrared Processing and Analysis Center in Pasadena and their team found 80 Cepheids in NGC 925. Their study is still in its preliminary stages but their results so far agree with previous estimates for the distance to this galaxy's group, about 32 million light-years.

These two additional distances aren't sufficient to revise the initial estimate of the Hubble constant, so the key project team is waiting patiently until all the selected galaxies have distances established. Then they hope to have enough data to determine the Hubble constant to an accuracy of better than 10 percent.

For determining the distances to remote galaxies, Mario Hamuy and Mark Phillips of the Cerro Tololo Inter-American Observatory in Chile and their colleagues use the brightnesses of type Ia supernovae. These supernovae arise when a white dwarf star in a binary star system swallows some mass from its companion star. The extra mass exceeds the mass limit for the white dwarf and causes the star to explode.

Astronomers thought that all type Ia supernovae should have the same maximum brightness. But Hamuy and Phillips' group found that the stars have a small range in brightness. More important, they found that they could relate the maximum brightness to how fast the star decreases in brightness after its outburst.

Comparing the maximum brightnesses with the observed brightnesses of supernovae, the team could determine relative distances to galaxies with a 10 percent accuracy. Unlike previous studies of type Ia supernovae, the astronomers find that the Hubble constant determined from their supernovae distances agrees with the value obtained from Cepheid studies.

A team led by Greg Aldering of the University of Minnesota in Minneapolis discovered 50 galaxies in it. Although a few interlopers were previously known, this large collection enabled the team to investigate how the galaxies were distributed through the void. Comparing the observed distribution with computer models, the astronomers find support for the idea that the voids formed as gravity drew galaxies into larger structures.

The gravity that pulled galaxies into clusters and sheets of clusters isn't strong enough to stop the expansion of the universe. That's the conclusion of a group of Caltech astronomers led by George Djorgovski.

Using the 10-meter Keck Telescope on Mauna Kea in Hawaii, they have counted galaxies in small patches of sky down to a limit of about 24th magnitude. As the researchers probed to fainter limits, they found that the number of galaxies continued to rise. This is exactly the result expected from open universe models that predict the universe will expand forever. (See "Counting to the Edge of the Universe," April 1993, for an explanation of galaxy counts.)

It's reassuring that astronomy can somehow manage to learn the fate of the universe and discover how gravity in the early universe managed to create large sheets and voids. But all such answers always seem to be more than offset by new problems such as unclothed quasars. That's good because that's what drives astronomy, new challenges replacing the old. ☐

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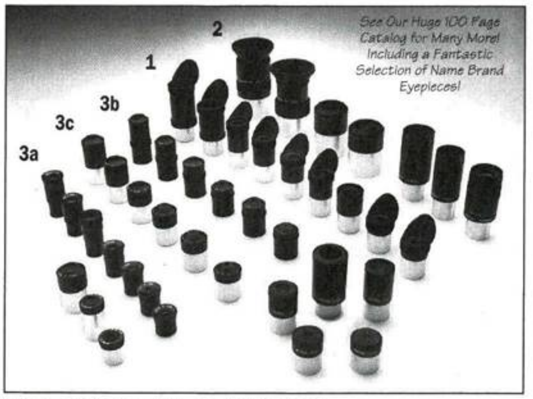

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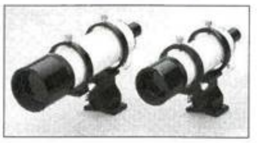

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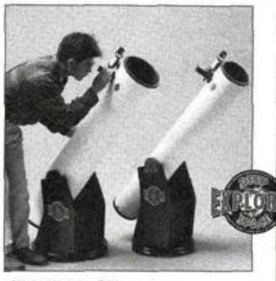

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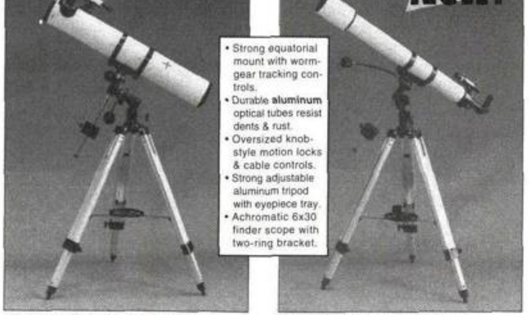

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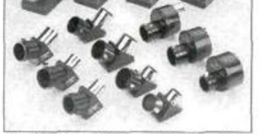

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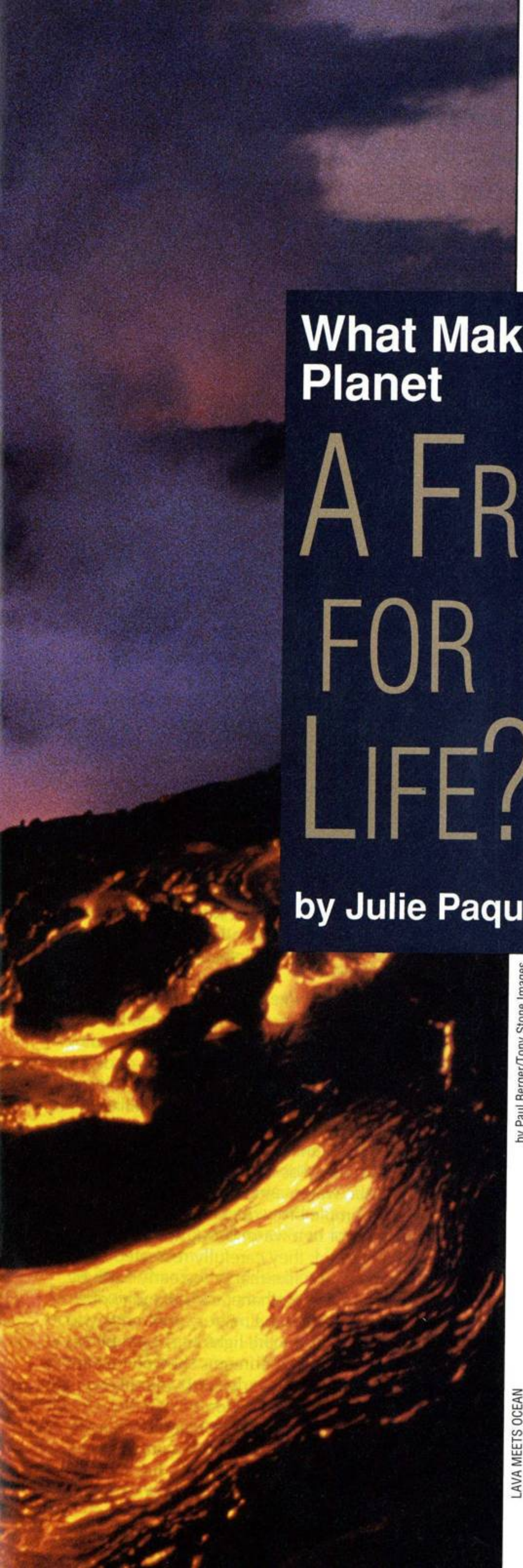
What Makes a Planet A FRIEND FOR LIFE?

by Julie Paque



by Paul Berger/Tony Stone Images

LAVA MEETS OCEAN

By all rights, Earth should be lifeless. As dead as a doornail. As dead, in fact, as the Moon, which it largely resembled four billion years ago.

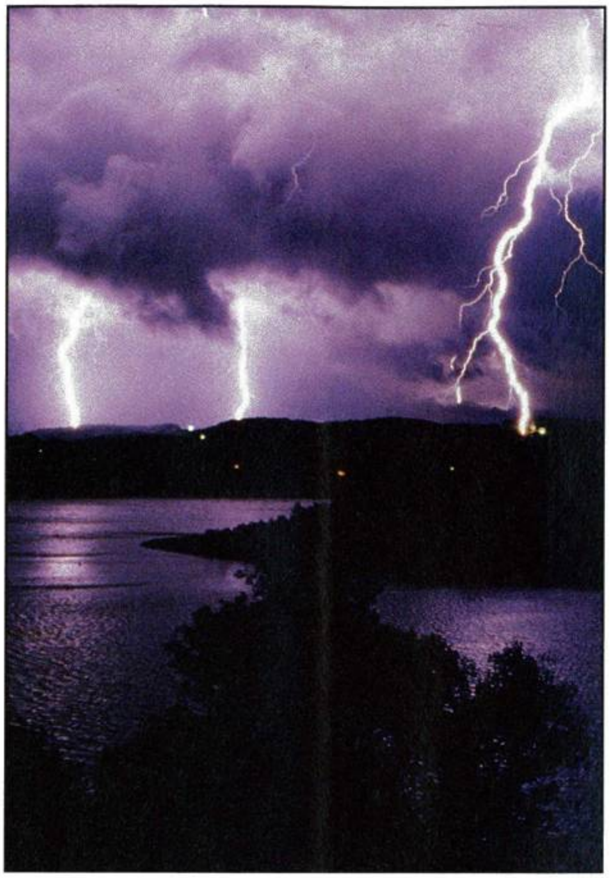
How life began on Earth is at present a mystery, although scientists have made a bit of progress charting its first steps.

Life's beginnings can be traced back to primitive organic molecules that formed on Earth and learned how to copy themselves. How the organic stuff that made self-replicating molecules got on Earth, exactly how it combined, and what that process says about the existence of life elsewhere in the universe are still largely open questions. Many scientists believe the molecules arose in the soupy oceans of Earth, while others think they were deposited on Earth from space. Understanding which idea is correct will permit astronomers to better estimate the relative number of living planets, which they have already done in rough fashion using a formula called the Drake equation. It uses a number of variables about stars, planetary systems, and the chemistry of life to estimate the possible number of living planets in the universe.

It's ALIVE!

To search for life's origins astronomers must first define life. Living things are organisms as we know them on Earth, organisms based primarily on carbon but also on hydrogen, oxygen, and nitrogen. Imagination, with generous assistance from television dramas, suggests that other forms of life, perhaps based primarily on some element other than carbon, may exist elsewhere in the universe. But as yet scientists have no evidence to support the possibility of life based on other elements, so this discussion will focus on life as it exists on Earth.

The early oceans provided a habitat where organic molecules could combine into amino acids.



THE POWER OF LIGHTNING

by Greg Blount

Once upon a time humans considered the constituents of life to be the "elements" fire, water, air, and earth. Now of course scientists know the periodic table of the elements and have a detailed knowledge of organisms on the molecular and cellular level.

All living beings are composed of cells, and within each cell are proteins, which regulate carbohydrates and fats. Proteins in turn are composed of amino acids. The nucleic acids RNA (ribonucleic acid) and DNA (dioxyribonucleic acid) within the cells orchestrate how these amino acids link into proteins.

Besides being composed of cells, living beings share other characteristics. They metabolize energy from the environment (by eating), and they reproduce and pass along their genes to succeeding generations. Mutation, which introduces random changes in cells, is also a factor in the evolution of life, although only a moderate one. Such changes sometimes create stronger, more efficient individuals that compete more successfully for the available food and have a better chance of surviving to pass along their genes than average beings. Additionally, some living beings are sentient, meaning they have the power of perception by sense. Animals and plants share these traits.

The Cosmic Seeds of Life

Until recently, science continued to ask how the nucleic and amino acids arose. They have long believed compounds as complex as amino acids formed from methane, water, and ammonia. To do this on early Earth, two other things were needed, an oxygen-poor environment (like that on early Earth) and energy such as lightning, volcanic eruptions, or simply the Sun's radiation. The amino acids then formed proteins and nucleic acids. DNA and RNA are the blueprints for proteins, but they also need proteins as catalysts. So molecular biologists have something of a chicken and egg problem. Which came first — proteins or nucleic acids? Current research leans towards the RNA-first solution.

Whichever chemicals battled their way out of the soup first, life's stage was set as long as four billion years ago, when the number of objects impacting onto our planet started to slow down. Periodic impacts of large comets and asteroids undoubtedly changed the variety and quantity of organic material available to make more complex molecules. The first fossil evidence of life contains bacterialike beings entombed in rocks about 3.5 billion years old.

In 1953, chemists Stanley L. Miller and Harold C. Urey produced amino acids in a laboratory from methane, ammonia, water, and hydrogen. If Miller and Urey had left this simple brew of chemicals on a lab bench, in a freezer, or in a warm bowl, nothing would have happened. Instead, they carefully recreated an oxygen-poor atmosphere like that of the early Earth by adding excess hydrogen, methane, carbon monoxide, and ammonia, and sparked the mixture with energy to simulate that contributed by the lightning common on early Earth. These classic experiments showed that the chemicals and conditions on early Earth could have produced amino acids in a very short time.

Since the Miller-Urey experiment, scientists have investigated where such chemical activity might have occurred on early Earth. Two locales may have acted as the mixing bowl: Earth's atmosphere or its oceans. The

Comets contain organic molecules. Could the organics have survived a planetary strike?

COMET LEVY

by Michael Stecker

viability of each area depends on the nature of Earth's early atmosphere, and scientists hold a range of opinions on that. Many believe it was highly reducing, or oxygen poor, while others disagree. Compounds important in forming life, like formaldehyde and hydrogen cyanide, are easiest to produce experimentally under oxygen-poor conditions. Earth's early ocean was almost certainly oxygen-poor, illustrated by Precambrian banded iron formations that precipitated from early seas. If the early atmosphere didn't, the early oceans almost certainly provided a habitat where organic molecules could combine into amino acids.

There's another possibility. Sherwood Chang, a planetary biologist at NASA Ames Research Center, points out that the ocean surface could have been a favorable setting. A complex set of physical and chemical processes operate here. Gases, aerosols, and dust from the atmosphere were continually mixed by wind and waves with the contents of the early ocean. Compounds were able to exist in gas, liquid, and solid states and ideal conditions existed for organic molecules to form.

So the first amino acids and proteins may have formed above the ocean or at the meeting place of ocean and volcano, which would have provided energy as well, and spread from there. Anyone who has seen dramatic images of an undersea vent or volcano splattering lava into the ocean can appreciate the unusual conditions. Life may have taken a foothold around a "black smoker" pouring energy out deep within the ocean.

Other locales may have existed, too. Verne Oberbeck, also at Ames, has proposed that raindrops may have hosted organic chemical reactions on early Earth.

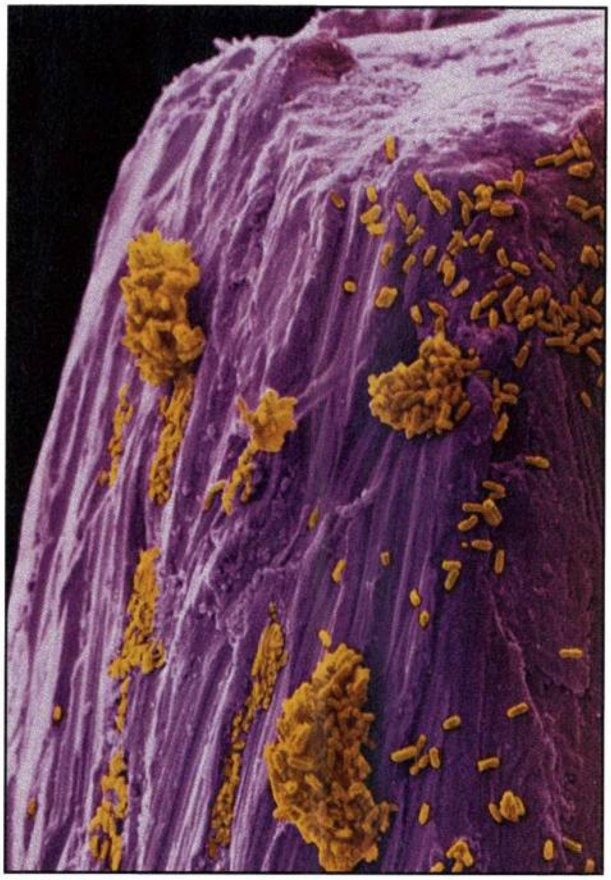
Organic Stuff from Space

On the other hand, comets and asteroids dumped a great amount of material onto early Earth. Anyone who followed last summer's impact of Comet Shoemaker-Levy 9 into Jupiter can appreciate how a comet could dump material onto a planet. Several billion years ago vastly more such objects were orbiting and impacting bodies in the inner solar system. Analysis of Comet Halley indicates that approximately one-third of its mass consists of organic molecules. If Halley is like other comets, then, comets contain substantial amounts of organic molecules.

Organics may have come from asteroids striking Earth, too. Carbonaceous chondrites, as their name implies, contain carbon and as much as 5 percent organic matter. The carbonaceous chondrite called Murchison, which fell in Australia in 1969, contains a variety of amino acids. Astronomers believe, then, that in some cases organic molecules from an asteroid or comet have survived the incredible crushing pressures and superhot temperatures of a planetary strike.

Not all of the organic material that struck Earth hit with the dramatic force of asteroids and comets, however. Just as significantly, a continuous silent rain of interplanetary dust particles falls slowly to Earth even today. These particles are microscopic, highly porous aggregates of mineral and organic material thought to have originated in comets and asteroids. Their carbon content can be as high as 40 percent. Three hundred tons of this stuff falls gracefully to Earth every year, gently depositing particles in our backyards and offices and on our houses and cars.

All living things metobolize energy from the environment and pass their genes to succeeding generations.



BACTERIA CLING TO A PIN by Tony Brain & David Parker, SPL / Photo Researchers

Some planetary scientists approach the extraterrestrial delivery of organics more creatively. Ted Bunch of NASA's Ames Research Center and Jeff Bada and Luann Becker of the Scripps Institution of Oceanography have found fullerenes in the Sudbury impact crater in Ontario, Canada. These organic compounds, also called buckyballs, probably formed during the Sudbury impact from carbonlike compounds in the impacting body. Bunch and his colleagues are now experimentally testing the survivability of organic material that could remain viable on Earth or create new compounds like buckyballs in an impact. Early test results are encouraging: Bunch's group has found that complex organics called polycyclic aromatic hydrocarbons are created during the impact of a carbonaceous chondrite into aluminum at velocities of up to 6.5 kilometers per second.

Survival of organics on a comet or asteroid remains an open question. Three years ago Christopher Chyba and his colleagues at Cornell University estimated the survivability of organic material as it passes through the atmosphere and impacts Earth. Large asteroids vaporize rock and water, destroying organic material, and generally devastate the environment. The large impact that produced the Chicxulub Crater on the Yucatan peninsula wiped out the dinosaurs. Such events were likely more common earlier in Earth's history and probably more devastating to the limited range of life forms present then. If Earth's early atmosphere had been denser, comets could have been slowed enough during entry for organic material to survive. Chyba's research shows that smaller, less dense asteroids or comets probably could contribute organic material to Earth, and certainly interplanetary dust particles could. (See "The Cosmic Origins of Life on Earth" by Christopher Chyba, November 1992.)

Even if asteroids and comets delivered life's building blocks, the terrific power of volcanoes, along with the ongoing bombardment, may have snuffed out life many times in its infancy. Early Earth was a rather inhospitable place. That's fortunate for humans, though. Life might be very different if one of the earlier attempts had taken. Wouldn't it be ironic if a comet carried the building blocks of life and another comet wiped out the dinosaurs? Perhaps a comet will strike Earth again, rendering humans extinct, and leaving the planet open for a third master species — maybe ferrets or 13-lined ground squirrels.

Is Anybody Home?

Whether or not comets or asteroids helped life arise on Earth, our home planet and its inhabitants imply that life might be common on other planets in the Milky Way Galaxy and in other galaxies scattered across the universe. Frank Drake, president of the SETI (Search for Extraterrestrial Intelligence) Institute, has devised an equation to estimate the likelihood that technological civilizations exist in the universe (N):

$$N = R^* \bullet f_p \bullet n_e \bullet f_l \bullet f_i \bullet f_c \bullet L.$$

R^* is the rate of formation of stars suitable for development of intelligent life, and f_p is the fraction of stars with planetary systems. Of the planets in a planetary system, only a certain proportion have the environ-

Sentient life has the power of sense, intelligent life the power of creativity. How much of it lies out among the stars?

THE ART OF SENTIENCE by Murray & Associates/The Stock Market

mental conditions necessary to sustain life (n_e), and only some of those planets will actually have life (f_l). Intelligent life will emerge on only a fraction of the planets (f_i) that contain life of any sort, and only some will be technologically advanced enough for their existence to be detectable from space (f_c). The factor L in the Drake equation reflects the length of time detectable signals are released into space. If all global lifespans of technological species survive only thousands of years our chance of detecting them is lower than if they survive for millions of years.

Placing conservative estimates for each of these factors into the equation leads to the conclusion that the chance for intelligent life elsewhere in our universe is indeed good. The chance that life of any sort exists elsewhere is even better. Astronomers know the physical laws and chemistry of the universe hold constant everywhere astronomers observe them, even in the hearts of quasars in the early days of the universe some 15 billion years ago. Our Milky Way Galaxy contains as many as 400 billion stars. Astronomers estimate that at least 100 billion galaxies exist. You figure it out: Even with ridiculously conservative estimates, the potential number of stars with planets that have life is astonishingly high. That does not mean that astronomers can find life with ease, however.

Living on the only planet known to harbor life, astronomers have thus far concentrated their efforts on identifying star systems with Earth-like planets. Several problems complicate searches for planetary systems around other stars, mainly the difficulty in resolving a small, distant dark object near a star that is orders of magnitude brighter. Rather than observing in optical light, however, astronomers can observe in the infrared part of the spectrum to decrease this contrast, or they can indirectly detect planetary systems by measuring the gentle wobble in a star's path across the sky caused by the mass of orbiting planets.

Currently forming planetary systems are easier to observe, as the disks of gas and dust that surround their young suns absorb and emit lots more radiation than planets do.

A planet that supports carbon-based life such as ours must also have liquid water, and this considerably restricts the range of temperatures on the planet and requires an atmosphere so the water won't escape into space. Many other factors make life possible for humanlike beings, including visible light, gravity, a breathable atmosphere of oxygen and water vapor, and the right range of temperatures.

Beginning to comprehend how life on Earth rose out of a cosmic stew of organic molecules certainly gives us fresh respect for our fragile planet. Knowing what makes Earth habitable will help humans maintain their home and perhaps one day in the distant future allow our descendants to leave the planet, when our Sun ages, to find shelter among the stars. Perhaps in the interim humans will discover sentient life in the universe and come to learn the perspective of this life on our own civilization. If astronomers do discover the range of life that probably exists out there, it will certainly bring human beings a little closer in our common journey through space and time. □

Julie Paque is an associate research scientist at the SETI Institute in Moffett Field, California.

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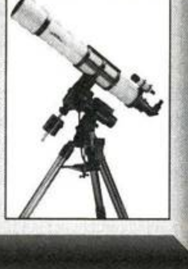

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SKY ALMANAC

Jupiter dominates the sky from dusk to dawn, Mercury puts on a good show in the morning, and Comet d'Arrest returns to telescopic visibility.

by Deborah Byrd

Highlights
by Rick Shaffer

Date	Event
	First Views:
1	Jupiter at Its Best. . . . . *(p. 59)*
9	The Moon Blocks the Bright Star Spica. . . . . *(p. 60)*
20	Pluto Passes a Bright Star. . . . . *(p. 62)*
All month:	
	Mercury in the Morning Sky . . . . *(p. 54)*
	Asteroid Juno at Best Visibility. . . . . . *(p. 60)*
	Observer's Challenge:
	The Return of Comet d'Arrest . . . . . . *(p. 62)*
	Dance of the Saturnian Moons. . . . . . . *(p. 63)*
	The Starry Sky:
	Ophiuchus. . . . *(p. 61)*

As twilight deepens to night on a warm June evening, the constellation Coma Berenices lies nearly overhead. This faint scattering of stars, best seen in a dark country sky, marks the direction to the north pole of our Milky Way Galaxy, the northern point around which our Galaxy spins. From Coma Berenices, you can let your eyes roam eastward to find the kite-shaped constellation Bootes, the lovely little semicircle of Corona Borealis, and the famous Keystone asterism in Hercules.

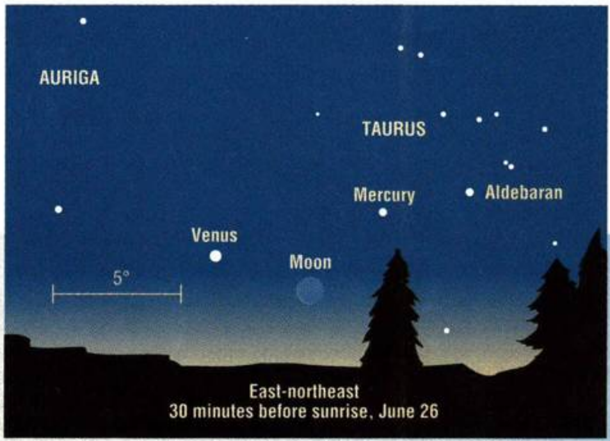
If your sky is dark enough, you'll spot the glittering arc of the Milky Way ascending in the east after these stars. You can get a sense of being inside the Galaxy if you watch Coma Berenices and the galactic north pole shift westward as night passes while the disk of the Galaxy rises into better view. Then think of the whole Galaxy spinning, with each ponderous turn taking 250 million years to complete. Then remember that the stars move toward the west and the Milky Way rises higher in the east on June evenings as a result of Earth's daily spin on its axis.

A warmly colored "star" appears in the southwest on these summer nights. It's **Mars**, the Red Planet, now two magnitudes fainter than it was at its opposition in February. Mars will linger in the evening sky throughout this summer and fall, finally disappearing in the Sun's glare around the end of this year. This planet is now on the reverse side of its long predawn apparition, which occurred during 1994. Mars always lingers uneventfully in the predawn sky, has a few bright exciting months around opposition, and then lingers again in the evening sky, fading slowly in brightness.

Mars now shines at magnitude 1.1 among the stars of the constellation Leo. In early June, it lies within 4° of Regulus, Leo's brightest star. The Moon sweeps past it and the star on June 4 and 5. It spends the month traveling eastward, from the lion's head to his hindquarters. When the month ends, it is not far from Denebola, the lion's tail. A telescope turned on the planet reveals a small, 6"-diameter disk.

The beginning of June

Mercury in the Morning Sky



East-northeast
30 minutes before sunrise, June 26

For those of you who get up early or stay up all night, Mercury puts on an impressive appearance in late June. It reaches greatest elongation on June 29, when it lies 22° west of the Sun. Fortunately for observers in the Northern Hemisphere, the ecliptic meets the eastern horizon at a fairly steep angle on mornings at this time of year, so much of that 22° translates into altitude above the horizon. For an observer at 40° north latitude, Mercury lies 8° above the east-northeastern horizon 30 minutes before the Sun rises that morning.

Mercury shines at magnitude 0.5 at greatest elongation and displays a decided yellowish cast. Through a telescope, the most you can hope to see of the innermost planet is its changing size and phase. In mid-June Mercury lies close to Earth and most of its sunlit hemisphere points away from us, so we see a relatively large disk (11" in diameter) in a crescent phase. By the 29th, Mercury has shrunk to 8" across and its phase has waxed to 35-percent lit. By mid-July Mercury's diameter will be down to 6" and its phase will appear nearly full as the planet sinks toward the eastern horizon and disappears from view.

Venus also lies in the morning sky this month, a bit lower and to the left of Mercury. Despite its low altitude, you shouldn't have any problem picking it out: At magnitude –3.9, it shines 4.8 magnitudes brighter than Mercury. The highlight of the month for both planets comes on the morning of the 26th, when the waning crescent Moon passes the pair. Look for the Moon about halfway between the two planets and a little bit lower in the sky. — *Rick Shaffer*

1995

JUNE

1 Jupiter is at opposition, 7 a.m. EDT (p. 59)

5 Mercury is in inferior conjunction, 2 a.m. EDT
The Moon passes 6° south of Mars, 4 p.m. EDT

6 First Quarter Moon is at 6:26 a.m. EDT

9 Spica is occulted by the Moon, 2 a.m. EDT (p. 60)

12 The Moon passes 2° north of Jupiter, 4 a.m. EDT
The Moon is at perigee (221,835 miles from Earth), 9:08 p.m. EDT

13 Full Moon is at 12:03 a.m. EDT

14 Jupiter passes 5° north of Antares, 10 a.m. EDT

15 The Moon passes 5° north of Neptune, 6 a.m. EDT
The Moon passes 6° north of Uranus, 3 p.m. EDT
Mercury passes 1.2° north of Aldebaran, 5 p.m. EDT

18 Mercury passes 1.1° north of Aldebaran, 10 a.m. EDT
Asteroid Juno is at opposition (p. 60)

19 Venus passes 5° north of Aldebaran, 1 a.m. EDT
Mercury passes 4° south of Venus, 3 a.m. EDT
Last Quarter Moon is at 6:01 p.m. EDT

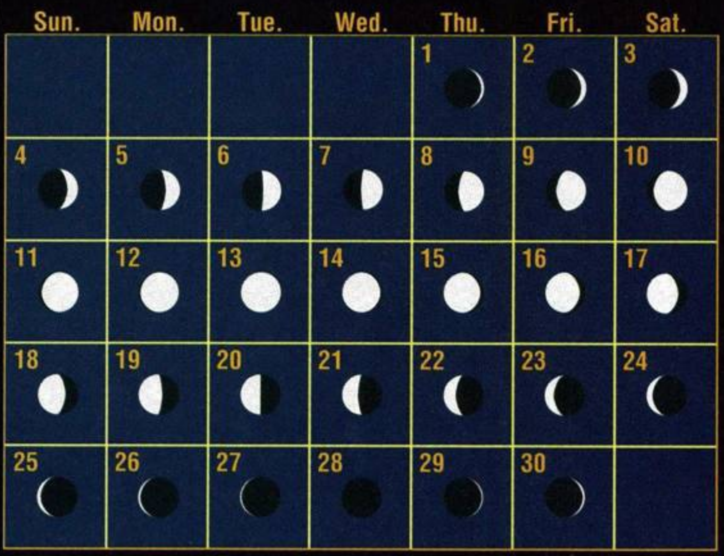
21 Summer solstice is at 4:34 p.m. EDT

25 The Moon passes 0.6° north of Mercury, 10 p.m. EDT

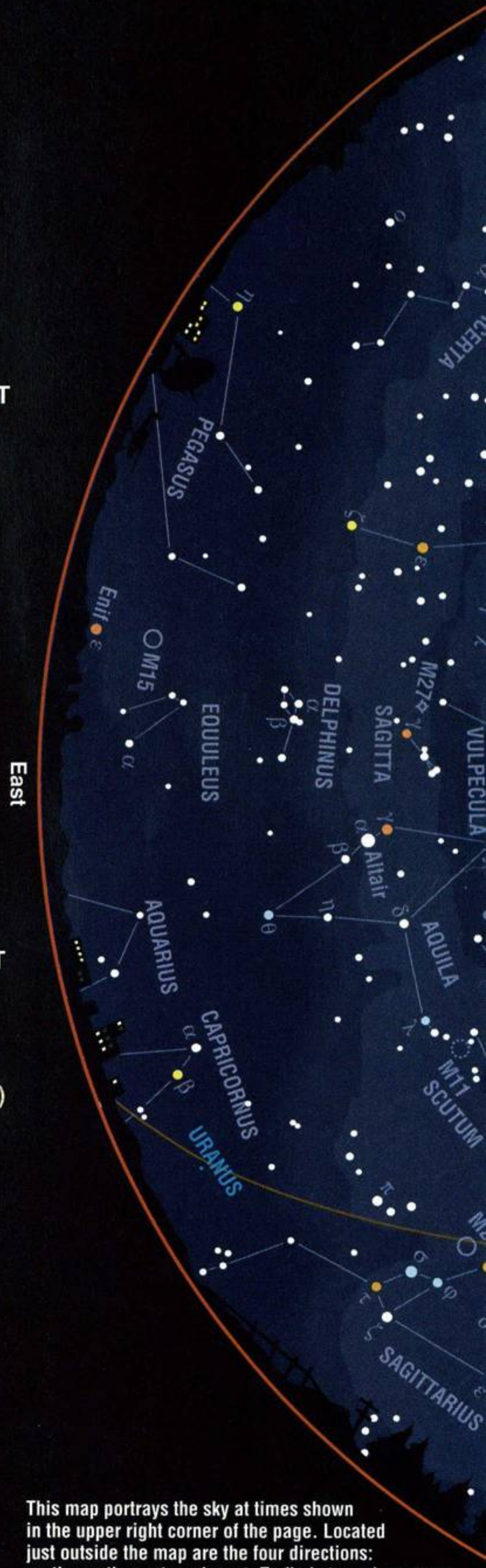
26 The Moon is at apogee (252,551 miles from Earth), 6:50 a.m. EDT
The Moon passes 3° south of Venus, 11 a.m. EDT

27 New Moon is at 8:50 p.m. EDT

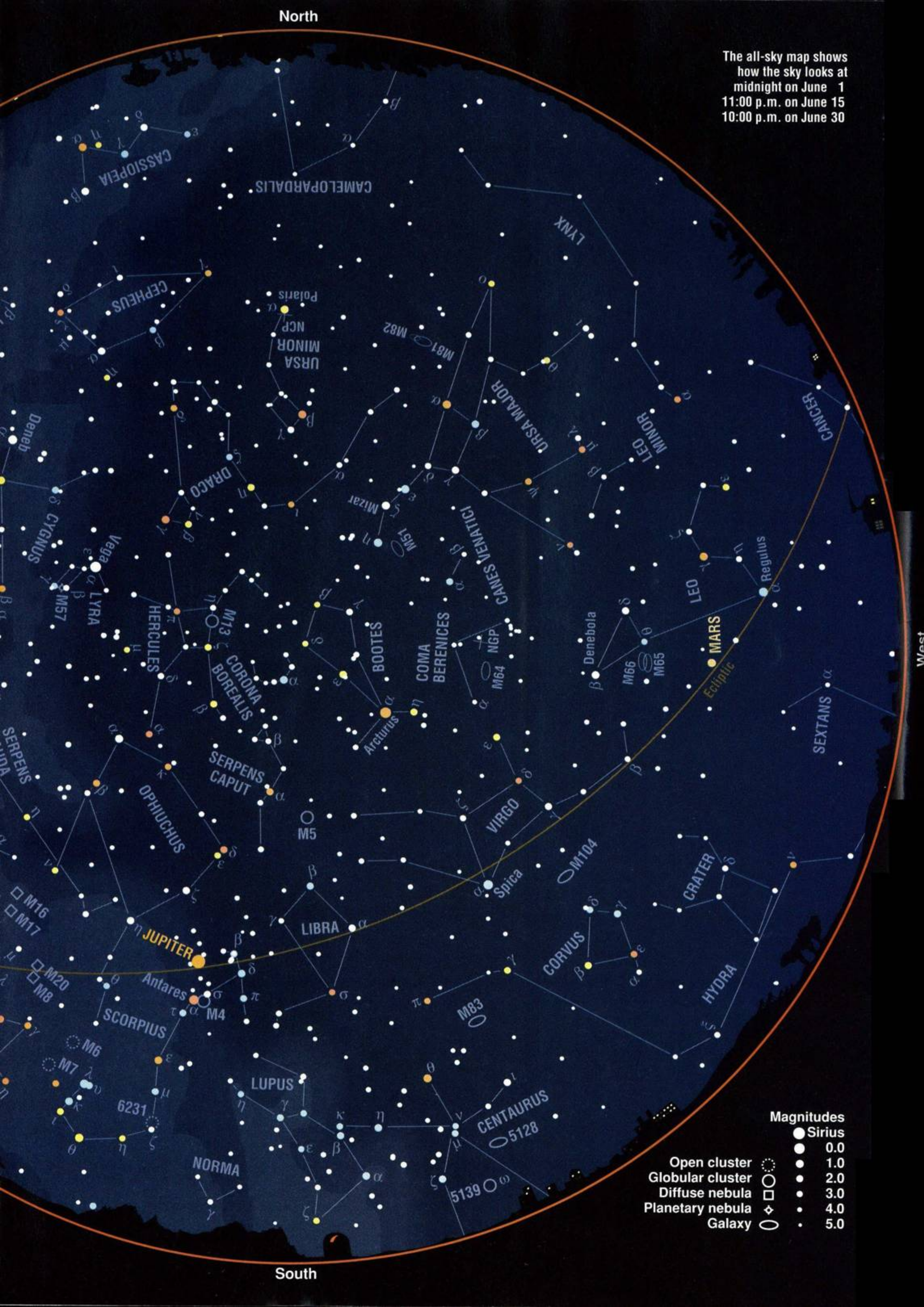
29 Mercury is at greatest western elongation (22°), noon EDT (p. 54)



Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

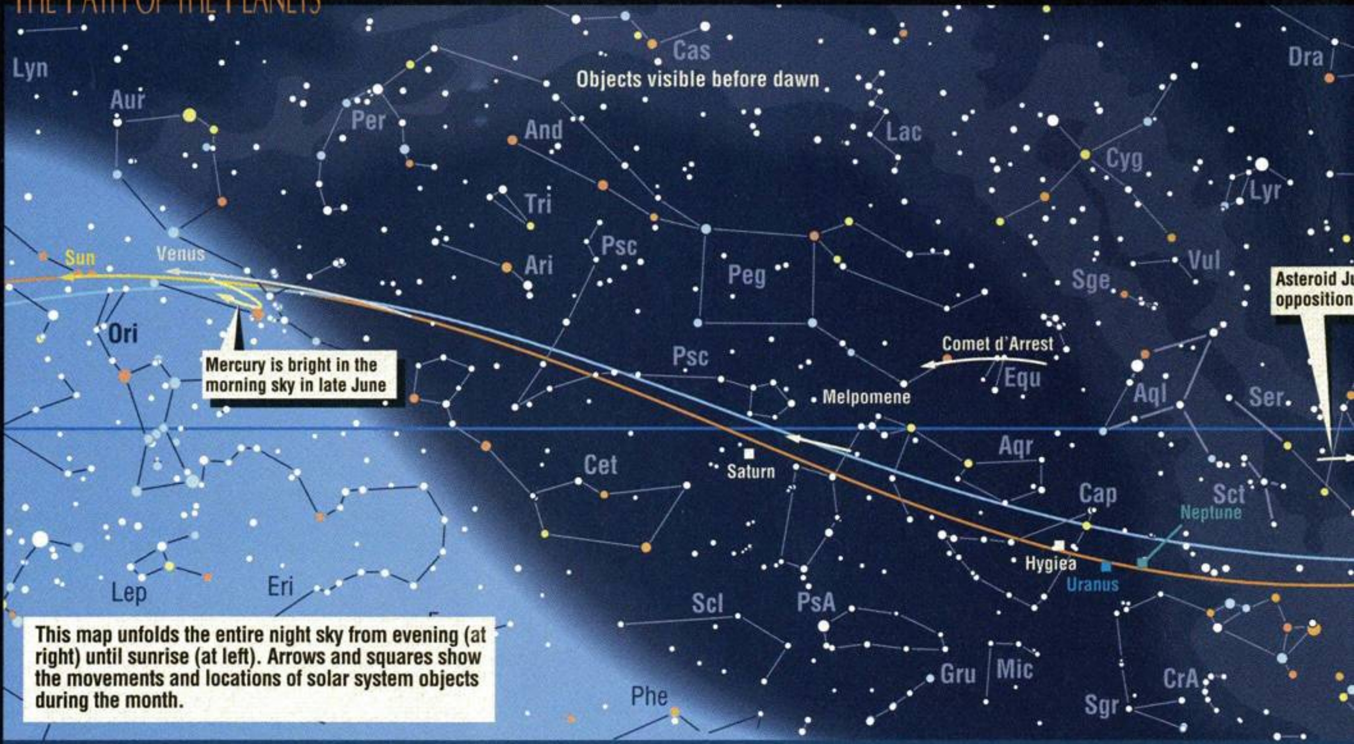


This map portrays the sky at times shown in the upper right corner of the page. Located just outside the map are the four directions: north, south, east, and west. To find stars above your horizon, hold the map overhead and orient it so a direction label matches the direction you're facing. The stars above the map's horizon now match what's in the sky.


North
South
West
CASSIOPEIA
CAMELOPARDALIS
LYNX
CEPHEUS
Polaris
NCP
URSA MINOR
M82
M81
URSA MAJOR
LEO MINOR
CANCER
Deneb
DRACO
Mizar
M51
CANES VENATICI
CYGNUS
Vega
LYRA
M57
HERCULES
M13
CORONA BOREALIS
BOOTES
COMA BERENICES
NGP
M64
Denebola
M66
M65
LEO
Regulus
MARS
Ecliptic
SEXTANS
Arcturus
SERPENS CAPUT
SERPENS CAUDA
OPHIUCHUS
M5
VIRGO
M104
Spica
CRATER
M16
M17
JUPITER
LIBRA
CORVUS
HYDRA
M20
M8
Antares
M4
SCORPIUS
M83
M6
M7
LUPUS
6231
CENTAURUS
5128
NORMA
5139
Magnitudes
Sirius
0.0
1.0
2.0
3.0
4.0
5.0
Open cluster
Globular cluster
Diffuse nebula
Planetary nebula
Galaxy

The all-sky map shows
how the sky looks at
midnight on June 1
11:00 p.m. on June 15
10:00 p.m. on June 30

THE PATH OF THE PLANETS


Lyn
Aur
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Cas
Objects visible before dawn
And
Lac
Cyg
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Lyr
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Ari
Psc
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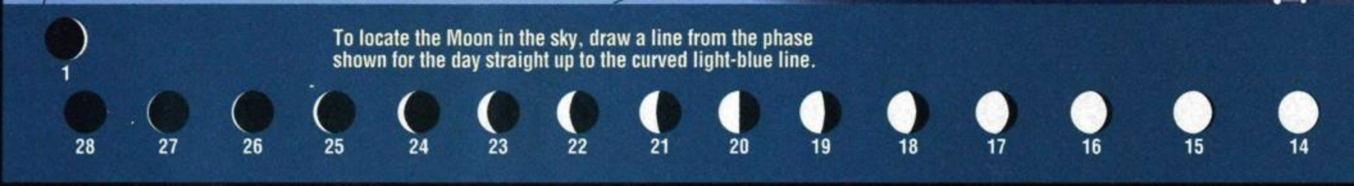
Asteroid Ju
opposition
Sun
Venus
Ori
Mercury is bright in the morning sky in late June
Psc
Comet d'Arrest
Equ
Melpomene
Aql
Ser
Cet
Saturn
Aqr
Cap
Sct
Neptune
Hygiea
Uranus
Lep
Eri
Scl
PsA
Gru
Mic
CrA
Sgr
Phe

This map unfolds the entire night sky from evening (at right) until sunrise (at left). Arrows and squares show the movements and locations of solar system objects during the month.


1
28
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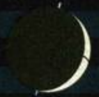
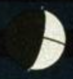
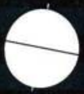
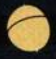
16
15
14

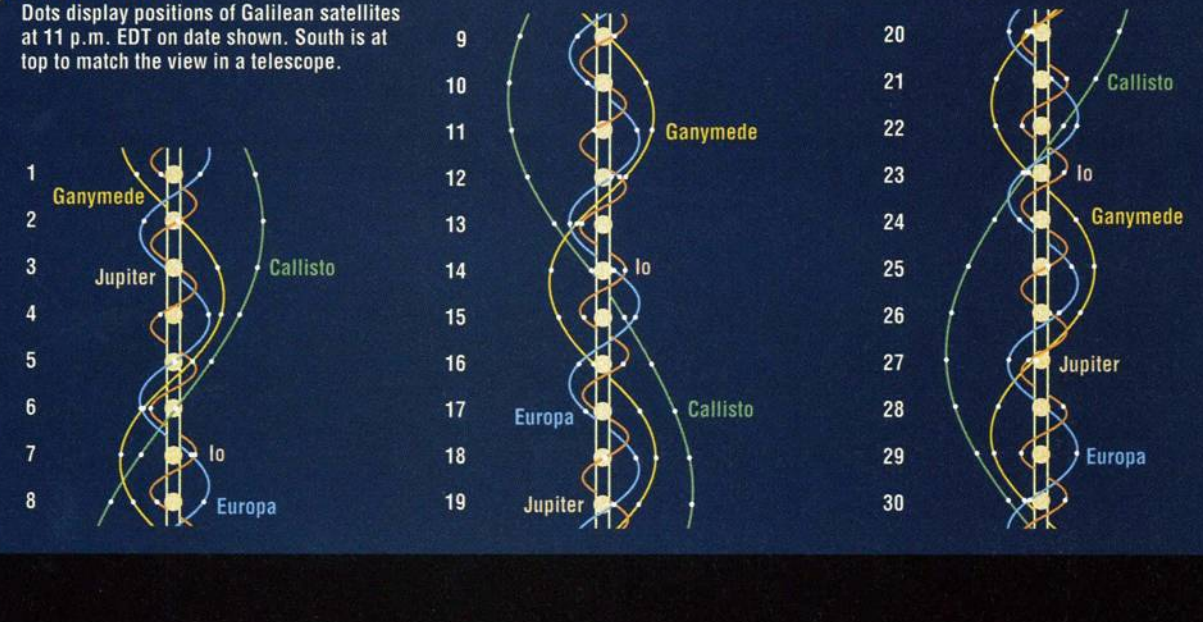
To locate the Moon in the sky, draw a line from the phase shown for the day straight up to the curved light-blue line.

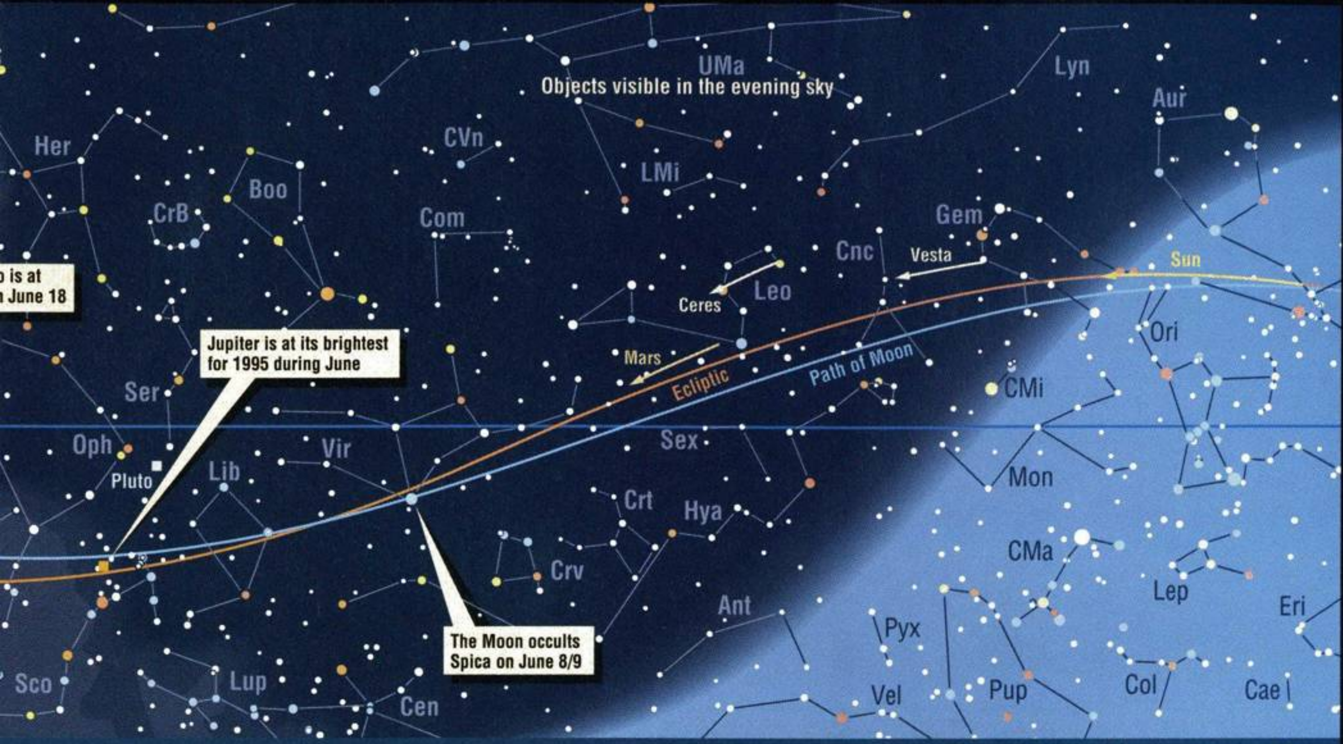
PLANETS	MERCURY	MERCURY	VENUS	MARS	JUPITER
Date	June 15	June 30	June 15	June 15	June 15
Magnitude	2.8	0.5	–3.9	1.1	–2.6
Angular Size	11.2"	8.0"	10.3"	6.1"	45.3"
Illumination	8%	37%	95%	90%	100%
Distance (AU) from Earth	0.602	0.843	1.615	1.529	4.346
Distance (AU) from Sun	0.456	0.394	0.723	1.624	5.335
Right Ascension (2000.0)	4h36.4m	5h00.8m	4h14.3m	10h47.4m	16h29.2m
Declination (2000.0)	17°45'	19°32'	20°17'	8°50'	–21°01'

JUPITER'S MOONS

Dots display positions of Galilean satellites at 11 p.m. EDT on date shown. South is at top to match the view in a telescope.

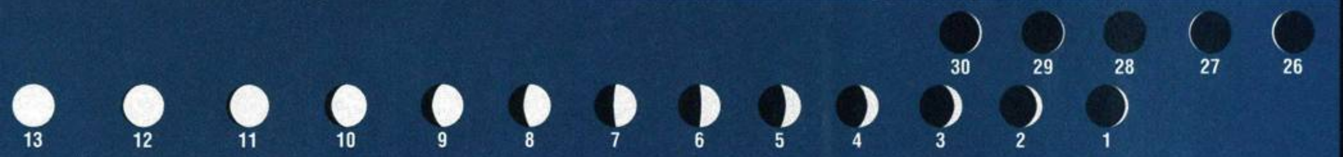



UMa
Objects visible in the evening sky
Lyn
Aur
Her
CVn
LMi
Boo
CrB
Com
Gem
Cnc
Vesta
Sun
Leo
Ceres
Mars
Ecliptic
Path of Moon
Ori
Ser
CMi
Oph
Sex
Vir
Pluto
Lib
Mon
Crt
Hya
CMa
Crv
Lep
Ant
Eri
Pyx
Sco
Lup
Cen
Vel
Pup
Col
Cae

o is at
n June 18

Jupiter is at its brightest for 1995 during June

The Moon occults Spica on June 8/9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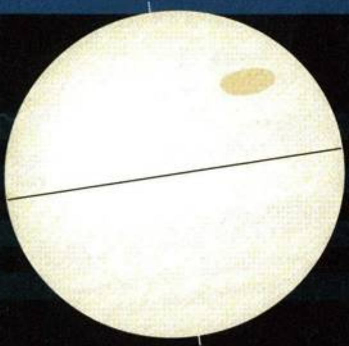
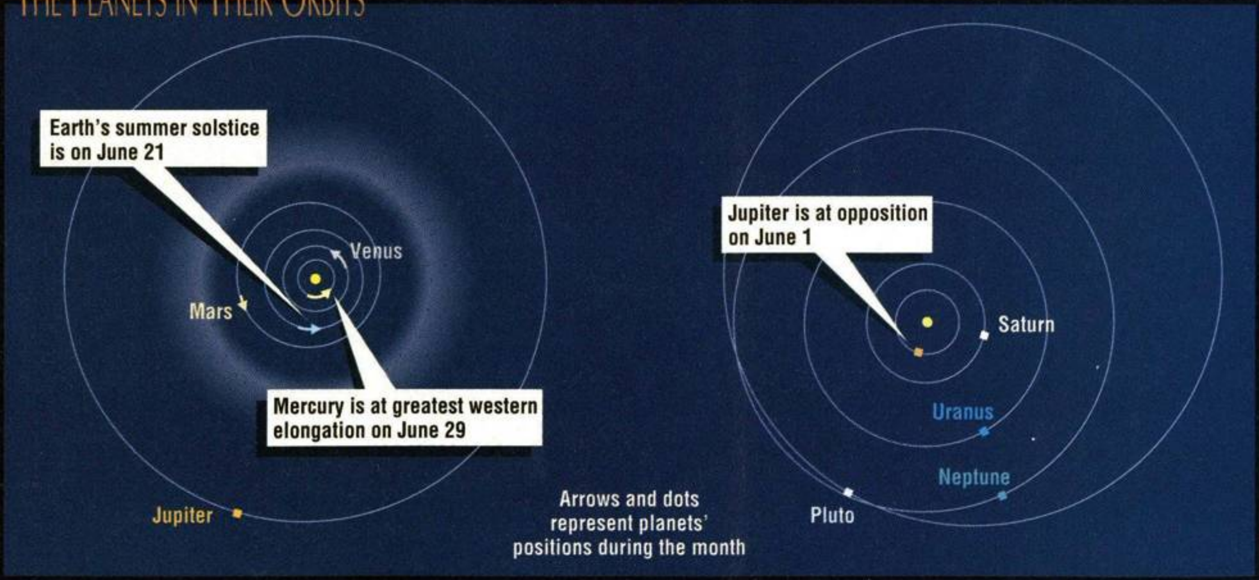


SATURN	URANUS	NEPTUNE	PLUTO
June 15	June 15	June 15	June 15
1.2	5.7	7.9	13.7
17.2"	3.7"	2.3"	0.1"
100%	100%	100%	100%
9.598	18.890	29.299	28.943
9.635	19.717	30.170	29.841
23h42.8m	20h08.8m	19h47.5m	15h57.7m
–4°05'	–20°43'	–20°35'	–6°18'

THE PLANETS IN THEIR ORBITS


Venus
Mars
Jupiter
Saturn
Uranus
Neptune
Pluto

Earth's summer solstice is on June 21

Mercury is at greatest western elongation on June 29

Jupiter is at opposition on June 1

Arrows and dots represent planets' positions during the month finds **Pluto** only ten days past its opposition. It is still at its brightest for the year, but at magnitude 13.7, it is a thousand times too faint to see with the naked eye. An 8-inch or larger telescope will reveal Pluto as a starlike object moving slowly relative to the stars in the constellation Libra.

A bold white object ascends in the east each evening. This is the largest planet in our solar system, **Jupiter**, which comes to opposition on June 1. On this day, like a faster runner on an inside track, Earth sweeps between Jupiter and the Sun. Our faster motion in orbit places Jupiter 180° from the Sun once every 13 months. At opposition, Jupiter and the Sun are like two ends of a seesaw: As the Sun goes down in the west, Jupiter comes up in the east.

Since Earth never stops moving in orbit, the relative positions of the Sun, Earth, and Jupiter change. The result is that Jupiter rises earlier each evening. By the end of the month, it is easily noticeable, popping into view in the east as soon as darkness falls. Because it is closest to us near opposition (it is about 36 light-minutes away), it is brightest for the year at magnitude –2.6. There are many magnificent stars in the summer sky, but the King of Planets outshines them all.

Jupiter comes to opposition this year among the background stars of Ophiuchus, the Serpent Bearer. Because it lies so close to the southern boundary of Ophiuchus and this constellation is relatively inconspicuous, you may think that Jupiter is located in Scorpius this month. The planet lies only a few degrees north of Antares, the brightest star in the scorpion, the one representing the scorpion's red heart, and passes 5° north of Antares on June 14. Also, be sure to watch on the night of June 11, when the Moon lies very near Jupiter. By the end of June, Jupiter slides into the constellation of Scorpius.

Because it is closest to Earth around now, the planet appears at its largest through a telescope — and that is large indeed. It is a colossal world, with alternating dark belts and bright zones, a world of constant change. This month, the planet's swirling features are at their best on a gigantic 45"-diameter disk. Notice how the planet is wider across its equator than from pole to pole. The squashed appearance of Jupiter results from its gaseous nature and its incredible rotation: it spins once in less than ten hours.

Uranus and **Neptune** rise earlier each evening as they head toward their July oppositions. By the end of June, they rise just an hour after sunset. Neptune lies in Sagittarius and Uranus is in its eastern neighbor Capricornus. Both planets are moving westward in front of the stars, in contrast to their normal eastward motion. On June 15, the Moon sweeps past

First Views:
Jupiter at Its Best

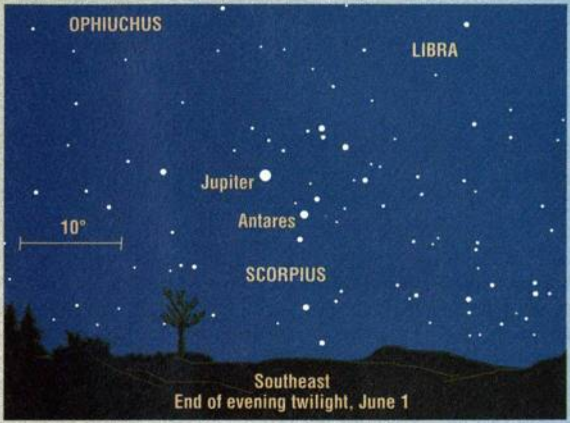
Donald C. Parker

As evening twilight descends this month, scan the eastern sky for the bright planet Jupiter. On June 1, it lies low in the sky when night falls and reaches its highest position in the south around midnight. That is the day of its opposition, when Earth passes between Jupiter and the Sun and the two planets are nearly at their closest to one another. Jupiter remains quite close to Earth throughout June and is very bright, shining at magnitude –2.6. It glows more brilliantly than any star and is surpassed by only Venus and the Moon.

Although it's unlikely this year that Jupiter will go through another bombardment like the one it suffered at the hands of Comet Shoemaker-Levy 9 in 1994, it's still the best planetary view of 1995. Unfortunately, Jupiter lies well south in the sky this year. To see it with the least amount of atmospheric interference, view it as it transits the meridian around midnight.

Jupiter is such a large, detail-rich object that it looks great most any time, but especially around opposition. It then appears 45.5" across and even a small telescope will reveal subtle cloud features when the seeing is steady. Jupiter's upper cloud deck is marked by alternating bands of light and dark clouds, called zones and belts, respectively. A light-blue filter will heighten the contrast between the belts and zones. And as you view these features, remember that they are about as wide as the Earth is thick.

The Equatorial Zone harbors many of the planet's more interesting features. Here you will find delicate blue festoons, which look like gray or bluish commas, arcing into the zone from the neighboring North Equatorial Belt. Of the two equatorial belts, the north one is usually more prominent. However, it is the south one that claims the Great Red Spot. Although the Red Spot is now far less colorful than its name implies, you should be able to see it cutting into the southern edge of the SEB around the eastern times listed at right. — *R.S.*



RED SPOT TRANSIT TIMES

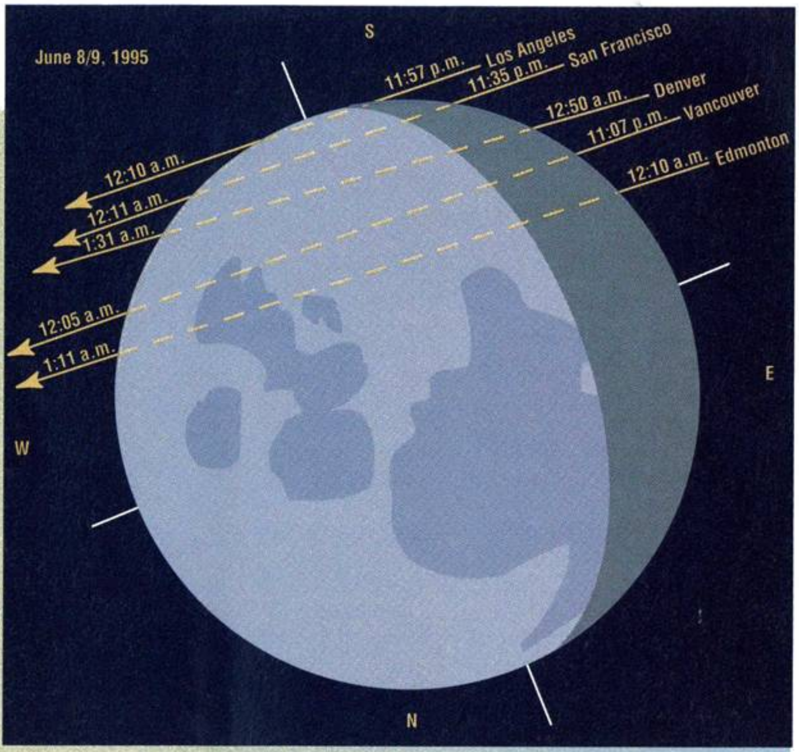
Date	Time
June 1	2:19 a.m.
June 3	3:57 a.m.
June 3	11:48 p.m.
June 6	1:26 a.m.
June 8	3:04 a.m.
June 10	4:42 a.m.
June 11	12:33 a.m.
June 13	2:11 a.m.
June 15	3:49 a.m.
June 15	11:41 p.m.
June 18	1:19 a.m.
June 20	2:57 a.m.
June 22	4:35 a.m.
June 23	12:26 a.m.
June 25	2:04 a.m.
June 27	3:42 a.m.
June 27	11:34 p.m.
June 30	1:12 a.m.

The Moon Blocks the Bright Star Spica

On the morning of June 9, the waxing gibbous Moon passes in front of the 1st-magnitude star Spica. Observers north of a line that passes roughly through Los Angeles, California, and Dallas, Texas, will see the Moon block, or occult, the light of Virgo's brightest star and later see the star reappear. From the central part of the continent, however, the disappearance will be visible but the Moon will set before the star can return to view. If you live south of that line, you'll see the Moon pass just north of Spica, and on the line, you'll see south polar regions of the Moon graze Spica.

The Moon is ten days old on the 9th, showing a waxing gibbous disk that is 79 percent lit. That means that the Moon's dark limb will first contact Spica, making it much easier to observe than the occultation of last April 14/15 when the Moon was Full. Fortunately Spica is bright enough that you should have little trouble watching it disappear with binoculars or a telescope and seeing it reappear if you have a scope that can track the stars.

Locate Spica at least 30 minutes before the occultation is scheduled to begin (use the diagram to approximate the time for your location). If you observe the occultation at high power and if the seeing is steady, you may find that Spica doesn't wink out suddenly. Instead it may brighten, dim, and brighten several times. This effect is caused by viewing the diffraction pattern, or series of light and dark rings, exhibited by a star when viewed through a telescope as the star's light is also being diffracted by the Moon's limb. — *R.S.*

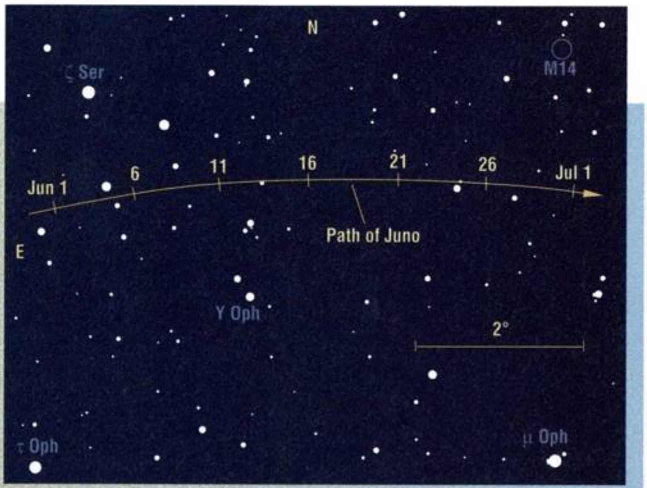


Asteroid Juno at Best Visibility

Asteroid 3 Juno, the third minor planet to be discovered, lies opposite the Sun in our sky on June 18. It thus rises at sunset, lies highest in the south at midnight, and sets at sunrise. Juno is also brightest at opposition, though you'll need binoculars or a telescope to spot this magnitude 10.0, 150-mile-wide asteroid.

Juno spends June in eastern Ophiuchus, not far from the border with Serpens Cauda. It is flying formation with Jupiter, which also lies in Ophiuchus though about 25° to the southwest of Juno. The asteroid lies about 2.2 astronomical units from Earth, only about half as far away as the 4.3-AU-distant Jupiter. (One AU is about 93 million miles, the average distance between the Sun and Earth.) You can see the effect of these different distances by watching the objects' motion across the sky: Juno moves about 50 percent faster than Jupiter.

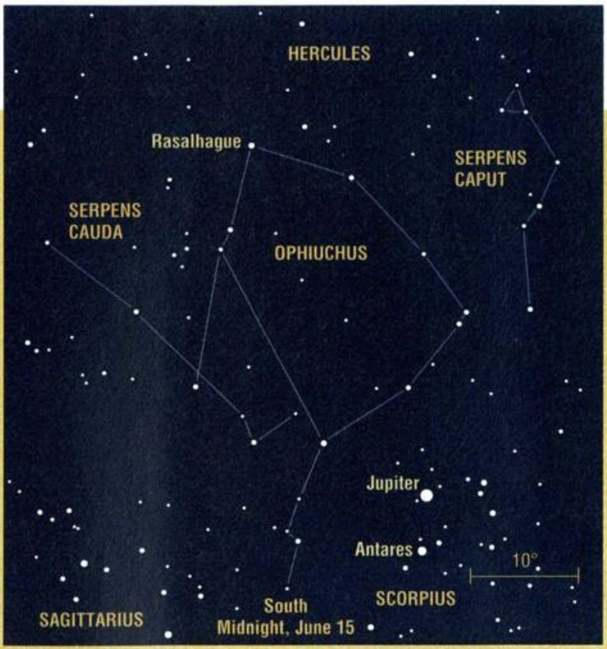
Although this region of sky is devoid of really bright stars (Zeta [ζ] Serpentis, at magnitude 4.6, is the brightest) it contains a wealth of fainter stars owing to its location in the outer fringes of the Milky Way. The best way to locate Juno is to use the finder chart or table of coordinates (which show the asteroid's positions at 11 p.m. EDT, 10 p.m. CDT, 9 p.m. MDT, and 8 p.m. PDT) to pinpoint the right area and then to sketch the field you see in a moderate-power eyepiece. Come back a night or two later and look for the object that has changed position. It is Juno. — *R.S.*



COORDINATES FOR JUNO

Date	R.A. (2000)	Dec.
June 1	18h02.1m	–5°04'
June 6	17h58.2m	–4°55'
June 11	17h54.1m	–4°48'
June 16	17h49.8m	–4°45'
June 21	17h45.4m	–4°44'
June 26	17h41.1m	–4°47'
July 1	17h36.9m	–4°54'

The Starry Sky: **Ophiuchus**



When the giant planet Jupiter comes to opposition this month, it is located in the large, sprawling constellation Ophiuchus, the Serpent Bearer. The name Ophiuchus comes from the Greek words *ophis*, meaning "serpent," and *ekhein*, meaning "holding." Under a dark sky you might be able to make out a giant man (with a figure like that drawn by a two-year-old) with a thin line of stars intersecting his body. This line of stars represents a separate constellation, Serpens, the Serpent.

Many cultures have seen Ophiuchus and Serpens wrestling among the stars for thousands of years. They are also bound in the ancient myths, where their association is more benign. In Greek mythology, Ophiuchus is sometimes called Asclepius, a child of the sun-god Apollo. According to some legends, he learned the power of healing herbs from a snake. He became known far and wide for his abilities as a doctor and was said to have possessed so great a skill that he even restored the dead to life.

Hades, god of the underworld, began to notice that fewer souls were entering his realm. He complained to Zeus, the king of the gods, arguing that only the gods were supposed to be immortal and that if Asclepius weren't stopped, soon people would be immortal, too. Zeus saw the logic of this argument and struck the doctor dead with one of his powerful thunderbolts. Afterward, he placed Asclepius in the sky, along with the snake that had taught him his craft. Asclepius, who is sometimes called the god of medicine, is always shown with a snake coiled around his walking stick. This symbol of a snake and a stick is still seen today as a symbol of the medical profession.

The constellation Ophiuchus could be considered an unofficial zodiacal constellation, because the ecliptic passes through it and thus the Sun, Moon, and planets all spend time moving in front of its stars.

From the vantage point of our time in history, Ophiuchus lies in a very central position on the celestial sphere. It lies exactly between the two celestial poles and midway between the vernal and autumnal equinoxes. Because Ophiuchus lies on the celestial equator, its stars rise due east and set due west.

Despite the prominence of its position, Ophiuchus does not contain a wealth of bright stars. Its brightest star shines only at 2nd magnitude. This is Rasalhague, which represents the head of Ophiuchus, a blue-white giant located about 60 light-years from Earth.

The most famous star in Ophiuchus is not visible to the naked eye. It is Barnard's Star, the fourth-nearest star to our solar syetem after the three members of the Alpha Centauri system. For many years this star was thought to have its own planets, although further investigation showed this not to be true.

When we gaze toward Ophiuchus, we are looking at a region of space close to the center of our Milky Way Galaxy. Thus this region of the heavens is grand for sweeping with binoculars. Ophiuchus contains six of the original 104 Messier objects. It is especially known for its abundance of globular star clusters, which are spherical clusters containing hundreds of thousands of our Galaxy's most ancient stars. — *Deborah Byrd*

both planets within only nine hours, but a moonlit night is not the ideal time to see the faint planets. When the Moon is out of the way, use your telescope to peer at these worlds. Magnitude 7.9 Neptune displays a disk measuring 2.3" across and appears blue-green. The disk of 5.6-magnitude Uranus measures 3.7" across and is more blue-gray.

Saturn rises in the wee hours in June and appears high in the east before dawn. It remains in the constellation Aquarius, where it has resided for the past couple of years. At magnitude 1.2, Saturn appears slightly brighter now than it did earlier this year. Still, the planet is fainter than it might be at its current distance from Earth of about 900 million miles. That's because its broad encircling rings generally contribute a great deal to its overall brightness. In late May, Earth passed through the plane of the rings, so they are now turned nearly edgewise to us and are very difficult to see in a small telescope. Thus Saturn appears fainter than it would if the rings were more open. See "The Vanishing Rings of Saturn" on page 70 for more about the ring-plane crossing and what you can see.

Venus is speeding ahead of us in its smaller, faster orbit around the Sun. It will "turn the corner" in front of us and disappear into the Sun's glare in July. Right now, it rises about an hour before the Sun and appears very low in the east before dawn. It has faded in brightness over the past few months because of its increasing distance from Earth, but that doesn't stop it from outshining all other celestial objects except the Sun and Moon at magnitude –3.9. Telescopically, Venus now appears as a 10"-diameter, 95-percent-illuminated disk.

Mercury, the innermost planet, rushes between the Sun and Earth in early June. Its inferior conjunction comes on June 4/5. It then sweeps into the predawn sky, but it is not easy to spot at that time. You might try looking for it around June 19, when the innermost planet appears 4° south of its neighbor in the solar system, Venus. You will have to look exceedingly low in the east

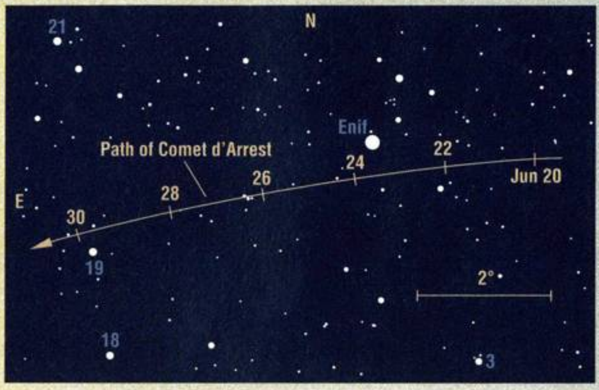
The Return of Comet d'Arrest

Hal Jandorf

It's been a long time since we've had a great comet appear in our skies. Oh sure, we had a great event last year when a swarm of tiny comets played mosquito to Jupiter's windshield. But no great comets, so we'll have to settle for a nice comet. Its name is d'Arrest, and it's a periodic comet that takes only 6.7 years to complete one orbit of the Sun.

June is just a warm-up for Comet d'Arrest, which is heading toward perihelion, its closest approach to the Sun, on July 27. This month it's a 10th-magnitude fuzzball moving east through Equuleus into western Pegasus, looking much like it did in 1976 (left). On June 23, it passes 0.5° south of the 2.4-magnitude star Enif. The finder map and table of coordinates show the comet's positions at 4 a.m. EDT (3 a.m. CDT, 2 a.m. MDT, and 1 a.m. PDT).

You may find that you see more each time you observe d'Arrest. This is your eye-brain combination learning "how to do it." If you don't see much when you view the comet this month, take heart. It should brighten to magnitude 6 or 7 by August. — *R.S.*



COORDINATES FOR COMET D'ARREST

Date	R.A. (2000)	Dec.
June 20	21h34.3m	9°37'
June 22	21h39.7m	9°30'
June 24	21h45.2m	9°19'
June 26	21h50.8m	9°06'
June 28	21h56.4m	8°50'
June 30	22h02.1m	8°30'

Pluto Passes a Bright Star

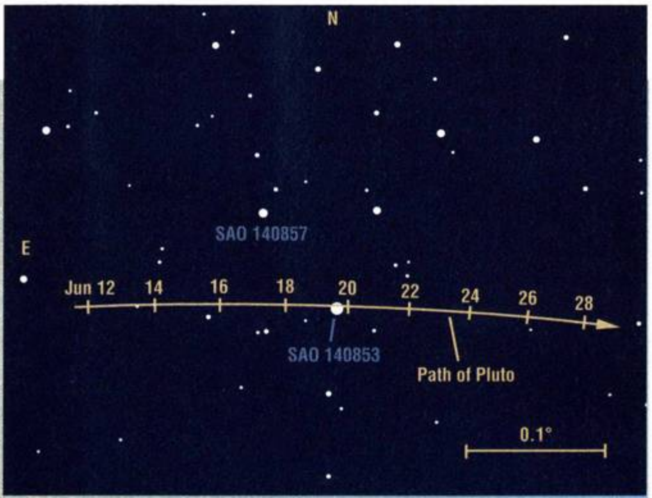
June 20 finds the most remote planet in our solar system passing just 5" north of the 7th-magnitude star known as SAO 140853. This proximity gives you an excellent shot at glimpsing the 13.7-magnitude planet.

If you're a beginner, SAO 140853 can serve as a pointer to Pluto, which glows 6.5 magnitudes dimmer than the star. The trick is to sketch the region with the star just outside the field of view so that its brilliance doesn't ruin your night vision. You'll want to observe the field for a few nights before and after the 20th so that you get used to the view and insulate yourself from bad weather. Pluto, of course, is the "star" that moves from drawing to drawing.

If you're a budding astro-imager or -photographer, you can capture Pluto's motion by taking exposures of the close approach as often as every 20 minutes. If you're using an 8-inch f/10 telescope, try an exposure of 8 to 16 minutes on ISO 800 to 1600 film, or 4 to 8 minutes using a CCD camera. Better yet, experiment to find the best exposure time before the 20th rolls around. — *R.S.*

COORDINATES FOR PLUTO

Date	R.A. (2000)	Dec.
June 12	15h57m52s	–6°17'44"
June 14	15h57m41s	–6°17'40"
June 16	15h57m29s	–6°17'38"
June 18	15h57m18s	–6°17'39"
June 20	15h57m07s	–6°17'43"
June 22	15h56m56s	–6°17'48"
June 24	15h56m46s	–6°17'57"
June 26	15h56m35s	–6°18'08"
June 28	15h56m26s	–6°18'21"



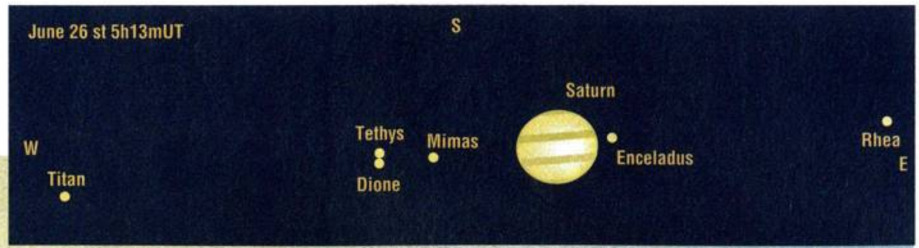
Observer's Challenge:

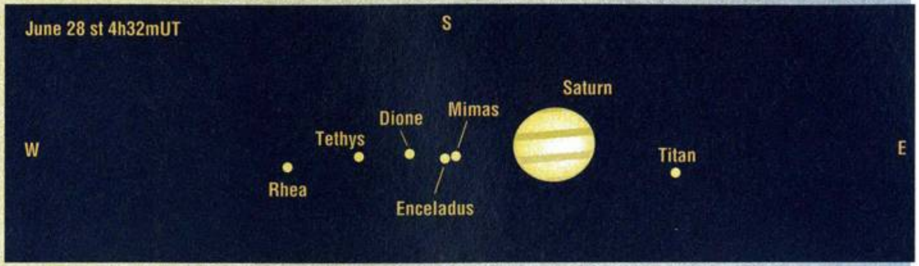
Dance of the Saturnian Moons

If you've been observing Saturn during the past few years, you no doubt have noticed that its rings have been getting closer to edge-on. About every 15 years, the plane of the rings tilt edge-on to our line of sight and the rings disappear from view. (See "The Vanishing Rings of Saturn," page 70.)

But there is another more subtle effect that happens as Earth passes through the ring-plane. Because most of Saturn's satellites orbit in nearly the same plane as the rings, these orbits are now also tilted nearly edge-on to our line of sight. When this happens, the satellites sometimes pass into the shadow of the planet or pass in front of or eclipse one another.

The table below lists the best events, though only some are visible from any one spot. From North America, the best eclipses by Saturn occur on June 25, when Saturn eclipses Rhea, and on June 27, when Saturn eclipses Titan. The best-timed mutual events are on June 26, when Tethys occults Dione, and June 28, when Mimas eclipses Enceladus. — *R.S.*





EVENTS OF THE SATURNIAN SATELLITES

Date	Begin Time	End Time	Event	Type of Event	Light Loss	Distance
June 2	14h04.5m	14h07.9m	Saturn eclipses Rhea	Disappearance	—	1.7
June 6	16h12.5m	16h17.2m	Dione occults Rhea	Partial	8%	6.3
June 6	21h35.9m	21h39.2m	Enceladus eclipses Mimas	Partial	95%	3.0
June 7	2h30.9m	2h34.2m	Saturn eclipses Rhea	Disappearance	—	1.7
June 11	13h31.5m	14h02.8m	Saturn eclipses Titan	Disappearance	—	2.4
June 11	14h57.3m	15h00.6m	Saturn eclipses Rhea	Disappearance	—	1.7
June 16	3h23.7m	3h27.0m	Saturn eclipses Rhea	Disappearance	—	1.7
June 17	1h52.9m	2h00.2m	Enceladus eclipses Tethys	Annular	23%	4.1
June 18	13h02.9m	13h04.5m	Tethys occults Enceladus	Total	20%	3.3
June 20	15h51.1m	15h54.4m	Saturn eclipses Rhea	Disappearance	—	1.7
June 21	23h18.5m	23h21.2m	Enceladus eclipses Mimas	Partial	58%	3.0
June 25	4h16.5m	4h19.8m	Saturn eclipses Rhea	Disappearance	—	1.7
June 26	5h12.2m	5h13.7m	Tethys occults Dione	Partial	3%	4.5
June 27	4h24.4m	4h28.0m	Rhea occults Tethys	Partial	33%	4.6
June 27	12h20.7m	12h45.6m	Saturn eclipses Titan	Disappearance	—	2.5
June 28	3h28.9m	3h30.5m	Dione occults Mimas	Partial	17%	3.0
June 28	4h23.4m	4h40.7m	Mimas eclipses Enceladus	Annular	58%	2.7
June 29	12h24.4m	12h26.0m	Mimas occults Dione	Partial	6%	3.0

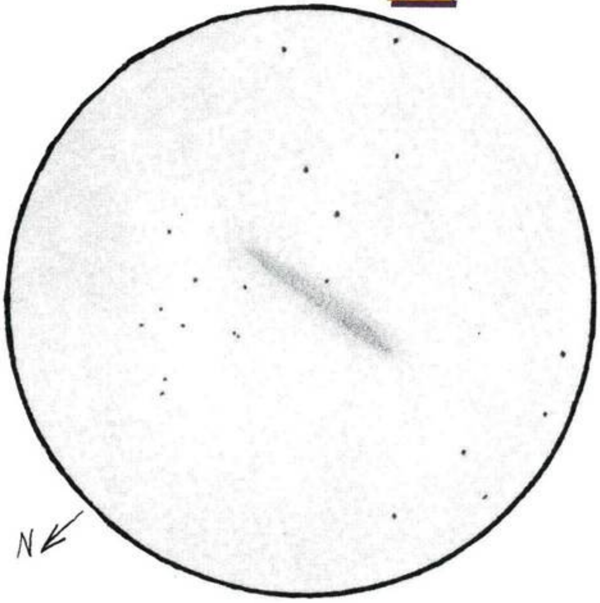
Begin Time: Universal time at beginning of event. (Subtract 4 hours to convert to EDT, 5 hours for CDT, 6 hours for MDT, and 7 hours for PDT.) **End Time:** Universal time at end of event. **Event:** The nature of the event and the objects involved. **Type of event:** Whether the event is partial, total, or annular. **Light Loss:** For eclipses — the percent of light lost by the eclipsed satellite at midevent; For occultations — the percent of light lost from the combined light of both satellites at midevent. **Distance:** The apparent distance of the satellite from Saturn's center expressed in Saturnian equatorial radii.

about half an hour before sunrise.

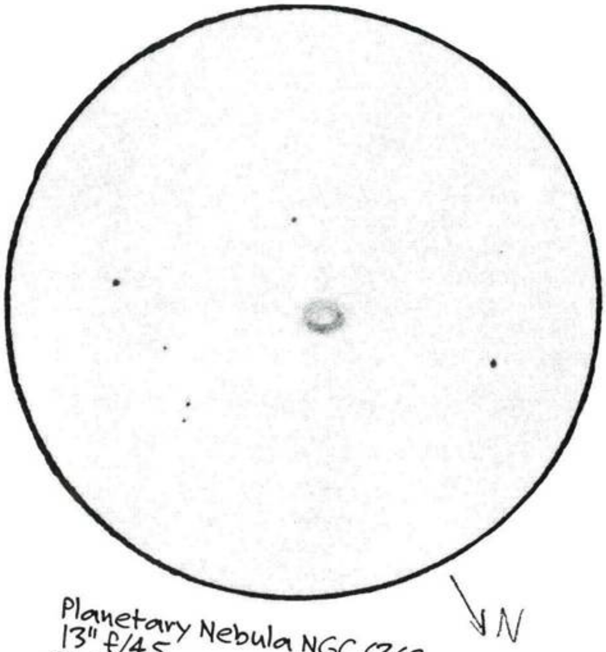
Mercury brightens rapidly in the last days of June. On the 26th, when the waning crescent Moon appears near it, it shines at magnitude 0.9. A bright star of nearly the same magnitude shines nearby. This is Aldebaran in Taurus. Mercury reaches greatest elongation on June 29, when it is 22° west of the Sun and appears low in the eastern sky shortly before dawn. A peek through a telescope at Mercury on that day reveals the planet as a waxing crescent world measuring 8.2" across.□

Deborah Byrd writes the "Earth and Sky" radio series. Rick Shaffer lives in Arizona.

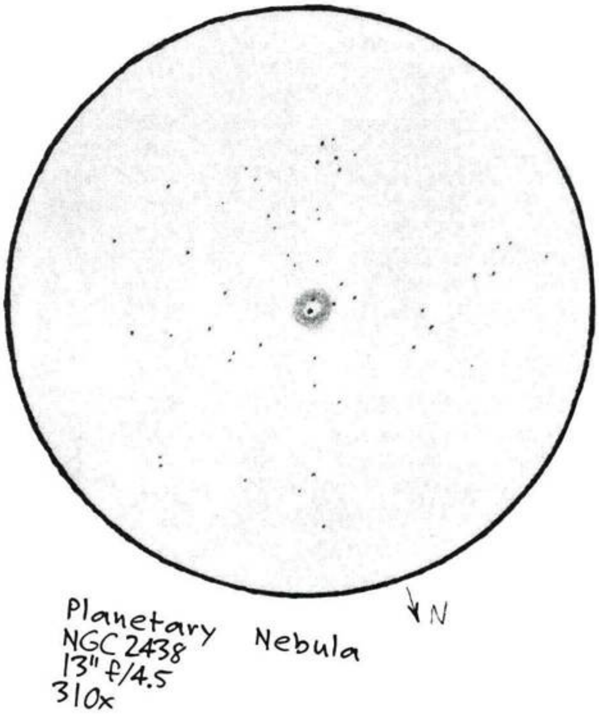
Deep-Sky on



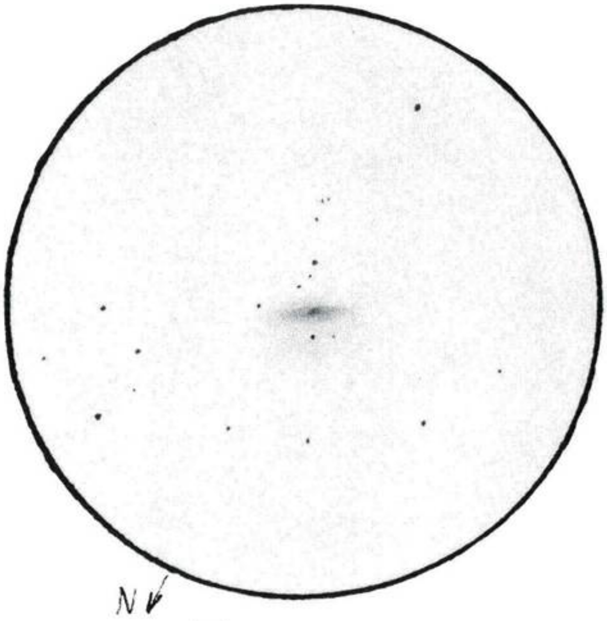
Galaxy NGC 5907
13" f/4.5
165x



Planetary Nebula NGC 6369
13" f/4.5
310x



Planetary Nebula
NGC 2438
13" f/4.5
310x

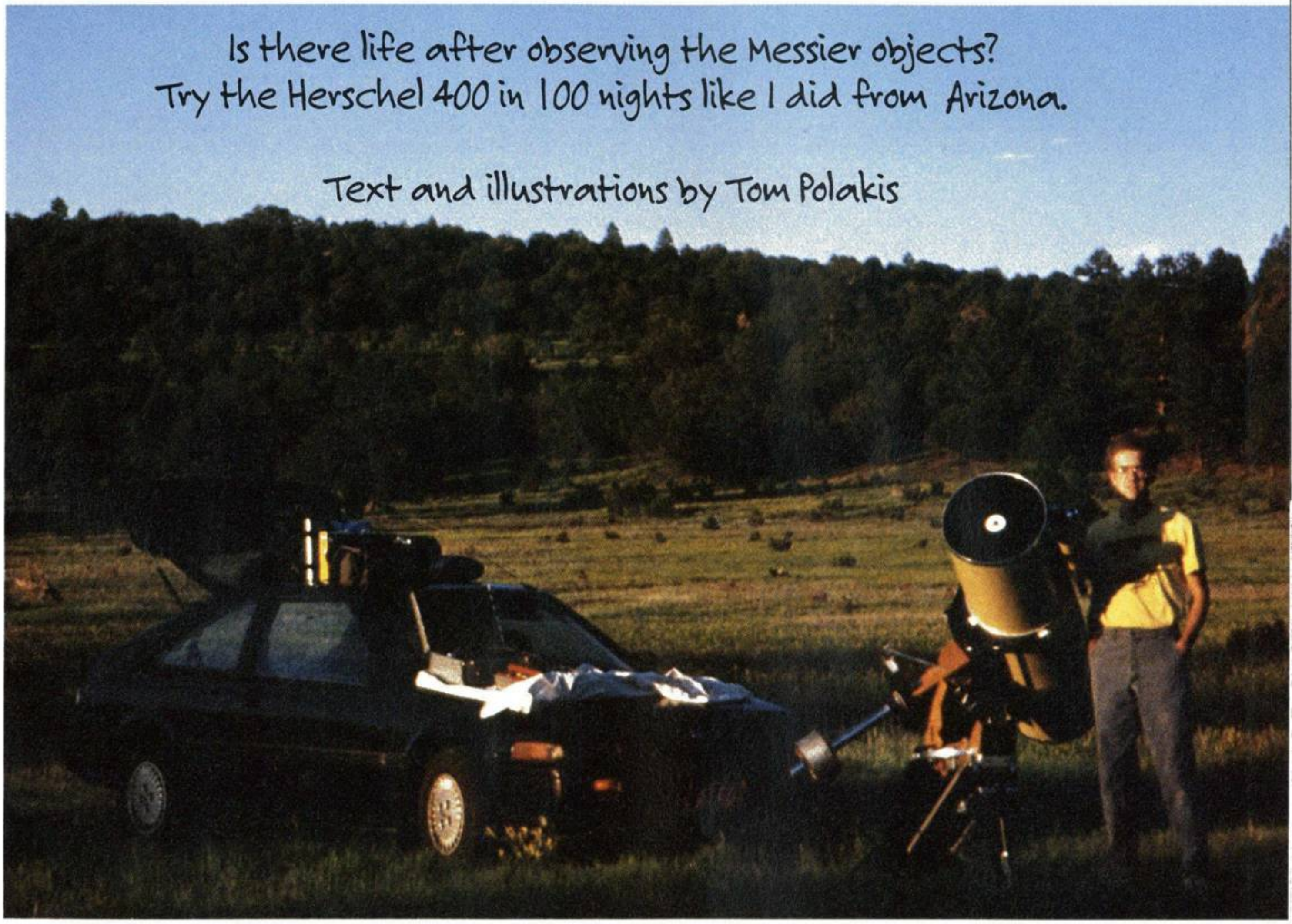


Galaxy NGC 2613
13" f/4.5
165x

Four a Day

Is there life after observing the Messier objects? Try the Herschel 400 in 100 nights like I did from Arizona.

Text and illustrations by Tom Polakis



Ready for nightfall at Vekol Ranch

A traveler's log. What better way to relive any journey? The impressions, sensations, discoveries . . . all as fresh as the day they happened. But the log I'm sharing doesn't wind its way through quaint French villages or up lofty Andean peaks. It's an observer's log that rambles by telescope into the realm of deep sky, a 100-night excursion through 400 beautiful and varied objects. Come share the trip's highlights through photos, drawings, and excerpts from my observing log.

As with many journeys, this expedition builds on previous experience. Most beginning deep-sky observers explore their way through Charles Messier's catalog, a listing of just over 100 objects that provides enough variety to intrigue any backyard astronomer. I did too. It's on the Messiers that you develop a trained eye and hone good habits, such as keeping an observing log. After a two-year commute through the list, I was ready for something new and challenging. It was time for the Herschels.

But not all of them. The 2,477-object Herschel catalog is named for 18th-century astronomer William Herschel, who observed mysterious blobs of light through his telescope — then the world's largest — while trying to gauge the universe's true extent. The objects he found are mostly galaxies, but scattered here and there are a few star clusters and gas clouds. Herschel used a complex designation, now obsolete, to list them. So today, we use an NGC designation drawn from the more recent, and far more extensive, *New General Catalogue of Nebulae and Clusters of Stars*.

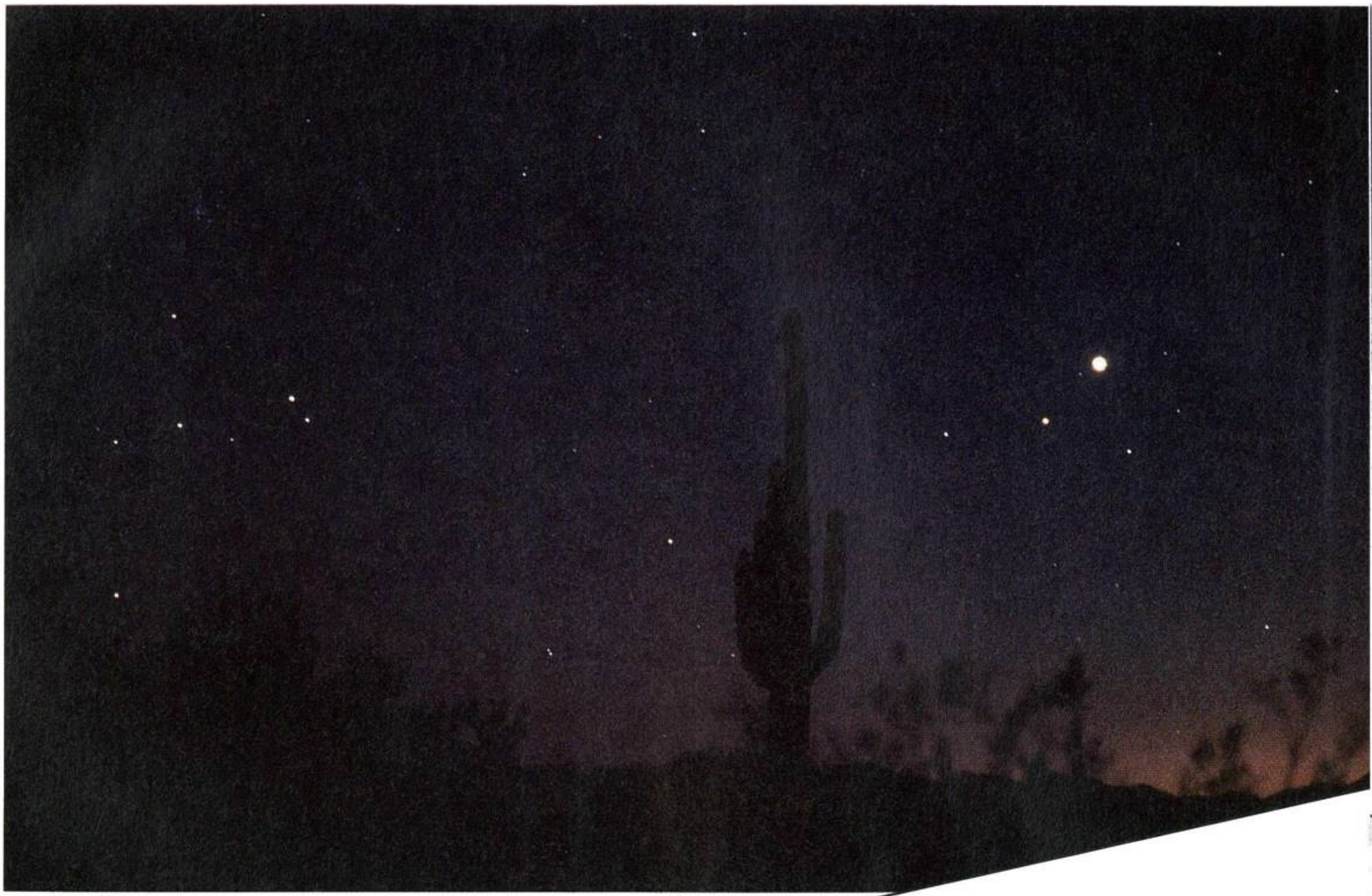
While many observers set out to land every object gleaned by Herschel, others like me concentrate on the brightest 400. They comprise the catalogue's best and offer a goal that isn't insurmountable. When I started the smaller and more manageable Herschel 400, I pictured myself actually finishing it. And since I have to escape the lights of Phoenix, Arizona, a smaller list is critical.

Phoenix is a big, light-polluted city. So when it comes to finding a reasonably dark site for observing, I'm in for at least an hour's drive. Selecting an observing site also depends on the time of year. During cooler, winter months I stay in lower-elevation desert, where temperatures rarely drop below freezing. During the summer, though, I escape the low desert's oppressive 100°-plus heat by traveling to higher elevations. Daytime/nighttime temperature swings of 40° are not uncommon in the high country, so I often pack moon boots and a down parka. Imagine the neighborhood stares that draws on a 110° afternoon!

Halfway to Flagstaff on Interstate 12 is my favorite high desert site: Dugas, Arizona. Dugas lies on a gently rolling expanse of chaparral and grassland between the low desert and high pine forests. At 4,000 feet, midnight temperatures during the hottest summers settle comfortably into the upper 50s. Because Dugas is only 70 miles north of Phoenix's light pollution, I typically don't spend much time viewing objects in the southern Milky Way. But any annoying glow to the south is more than made up for by the superb atmospheric transparency that comes with altitude. Under Dugas' skies, some of the Milky Way's features extend remarkably far from the galactic plane. In particular, there's one subtle extension to the main band that juts into northern Cepheus.

After drinking in what the naked eye sees, it's time to move to the eyepiece; my observing log shows that I saw 32 Herschel objects on 12 nights from Dugas. One particularly good target lies just east of the Big Dipper's handle in southern Draco: the edge-on spiral galaxy NGC 5907. At 165x, the galaxy extends almost a quarter-degree and appears barely 2' wide. The 10.4-magnitude streak shows some brightening toward the center, although the classic bulge seen in many edge-on galaxies is absent from this one.

Milky Way over Dugas



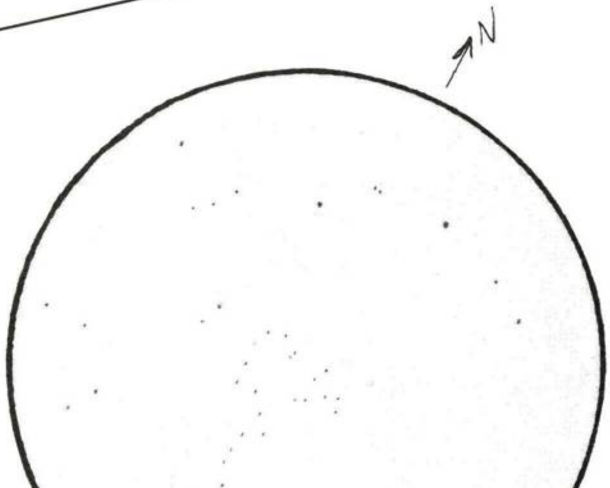
Scorpius, Saturn over Sentinel

Moving the scope south into Hercules, less than a degree from the northern sky's most impressive globular cluster, M13, is the galaxy NGC 6207. My 13-inch telescope shows this 11.6-magnitude galaxy as a small, bright glow of about 3'x1' with a much brighter center. It appears to have a bright stellar concentration at the core.

Further south, in southern Ophiuchus, is NGC 6369. Seldom glimpsed, this little planetary has a unique feature that's easy to see. A first glance shows a faint 13th-magnitude ring less than an arcminute across. When viewed at higher power, its pale ring splits in half, with the northern half appearing brighter.

As the hot Arizona summer moves into fall and into winter, I observe from a site that's closer to Phoenix and lower in elevation than Dugas. Vekol Ranch lies about 50 miles south of Phoenix in an expansive valley at 1,400 feet. While the city's glow washes out the northern sky up to Polaris, the flat southern horizon shows no signs of light pollution. The only sounds in this peaceful setting are the howls of coyotes and the hooting of owls. Local stories about snakes and scorpions are overblown; this remote site is one of the safest places in the state.

It was at Vekol Ranch that I had my first good view of Halley's Comet in 1986 as it was passing through



Open Cluster NGC 1664
13" f/4.5
115x

Sagittarius on a cool March morning. It was also here that I viewed 193 Herschel objects on 44 nights.

The winter Milky Way through the constellations Puppis and Monoceros pales in comparison to the more popular summer stretches of our Galaxy's disk. Gone are the star clouds and swaths of glowing gas. But what this part of the Galaxy lacks in splashiness, it makes up for in star clusters that dot the Milky Way down to the horizon. The low southern horizon at Vekol Ranch is advantageous for viewing objects in this part of the sky.

Under Vekol's sky I saw for the first time one of winter's most beautiful open clusters, NGC 2301 in Monoceros. As if forty bright stars filling a medium-power field weren't enough, it has a pair of blue and gold star right at the cluster's center. Another object not far away, NGC 2438, also appears in my observing notes from the Ranch. I never tire of viewing this 10th-magnitude planetary in Puppis, which lies in the rich star field of open cluster M46. Basking in the light of over a hundred cluster members, NGC 2438 offers a most pleasing view without any need for enhancement filters. The planetary's beautiful 66'-plus ring surrounds two stars, neither of which is a true central star.

Below Monoceros and close to the galactic plane lies Pyxis, the Compass. Nestled in it is the spiral galaxy NGC 2613. At magnitude 10.4, it looks quite bright in a 13-inch and has an elongated appearance. Like the M46/NGC 2438 combination, it also lies in a rich Milky Way star field.

The quest for winter Herschels sometimes takes me to another site that lies far west of Phoenix: Sentinel, a sleepy community in the low desert about a third of the way to San Diego off Interstate 8. From here Phoenix glows feebly from 90 miles and washes out only a portion of the northeastern sky.

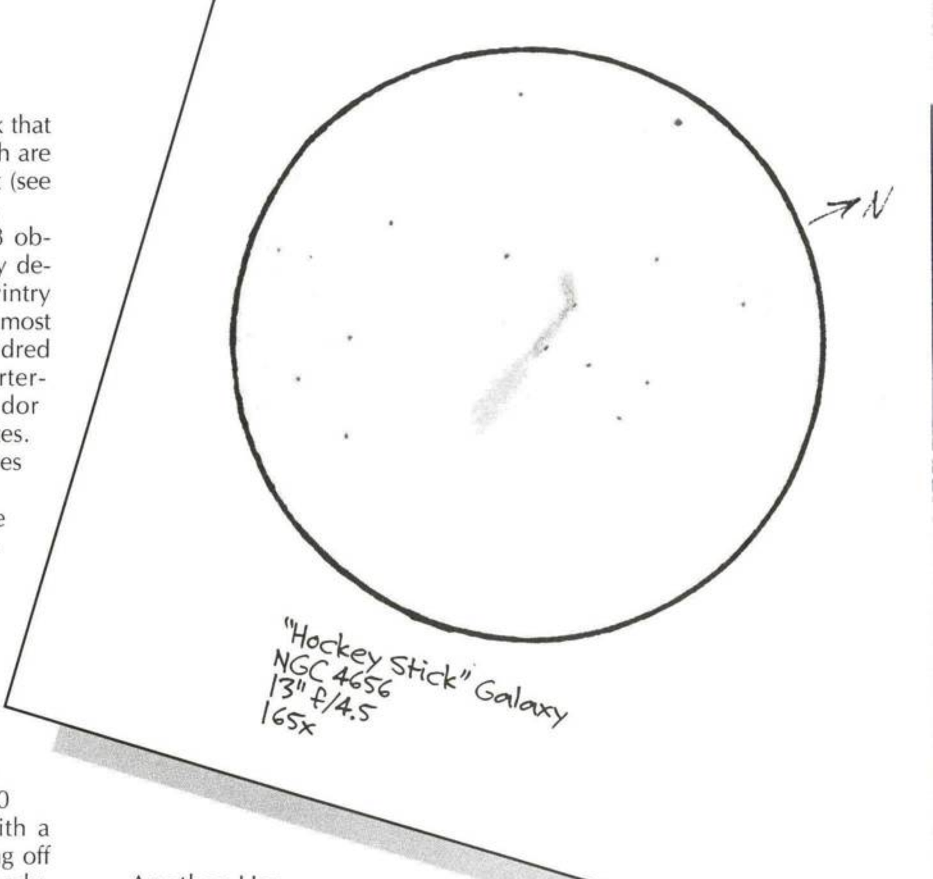
Sentinel's terrain is very flat, and only the most hardy vegetation survives summer bakings that often reach the 110s. With no nearby water and as U. S. Air Force bombing range boundary a stone's throw away, at Sentinel I'm typically left alone. The only hindrance on late winter nights comes from zodiacal light, which hangs in the western sky after evening twilight ends. The pale

Greeting dawn from The Rim

glow of the gegenschein doubles as a natural clock that tells me how many hours are left before dawn. Both are caused by sunlight reflected off interplanetary dust (see "Have You Seen the Zodiacal Light?" March 1995).

I hunted down 78 Herschel objects during 18 observing sessions at Sentinel. In my notes are many descriptions of objects high in the winter sky. A wintry constellation, Cassiopeia, harbors one of the sky's most beautiful open clusters, NGC 7789. Over a hundred 12th-magnitude stars pepper the cluster's quarter-degree area. NGC 7789 quickly loses its splendor when viewed from lesser, more light-polluted sites. And no photograph captures the distinct dark lanes that meander through this cluster.

East of Camelopardalis, through one of the more tenuous stretches of the Milky Way, lies the planetary nebula NGC 1501. A 13-inch scope at 310x shows a bright, 13th-magnitude round disk surrounding a 14th-magnitude central star that's easily seen. Careful viewing also reveals a dark center that belies the planetary's ringlike nature.



Moving into nearby Auriga, there's the open cluster NGC 1664 not too far from brilliant Capella. Against a starry background, 30 stars spread over a 18' field with a string of 10 additional stars trailing off south from the cluster's main body. The cluster members glow at a combined magnitude of 7.6, making them barely discernible against a wealth of background stars.

With spring comes a trip to the most remote of my observing sites, the Mogollon (pronounced "muggy-OWN") Rim, a cliff 1,500 feet high that extends 200 miles across central and eastern Arizona. I've found a few meadows on the Rim where the tall ponderosa pines do not obscure too much of the horizon. And boy, this site is transparent and dark; with the naked eye it's not uncommon to see stars down to 7th magnitude. The blaze of the Cygnus Star Cloud as it passes overhead is a sight to be experienced. If only the Great Sagittarius Star Cloud passed overhead. . . .

My notes show 21 observations on the four nights I spent viewing Herschel objects from the high-elevation Rim site. During late spring we see galaxies that dot the constellations Virgo and Canes Venatici. Some of them sport interesting shapes when viewed at high altitude.

Being a hockey fan at heart, I've always preferred the moniker "Hockey Stick" for a barred spiral galaxy in Canes Venatici, NGC 4656. The brightest portions of this 10th-magnitude galaxy form a blade, while the handle extends faintly away to the south. Overall, NGC 4656 is about 14' long and 3.3' wide. For a most pleasing view, frame it at very low power.

Another Herschel object typically overlooked in Canes Venatici, the Hunting Dogs, is NGC 5195, a companion galaxy to M51, the Whirlpool galaxy. It appears very bright at magnitude 9.6, with a core that is actually brighter than that of M51. NGC 5195 has a semicircular profile with its western end appearing truncated.

Further south, superimposed among the galaxies of the Virgo Cluster, is the bright globular cluster NGC 5634. Being only about 5' across, the 9.6-magnitude cluster requires good seeing to be resolved at all. The average optics of my 13-inch revealed some faint edge stars with difficulty.

My Herschel 400 Chronology harbors more sites and nights of observation than can be mentioned here. They range from the darkest site, the Texas Star Party's Prude Ranch near Fort Davis, to the brightest, Camp Oakes, site of the Riverside Telescope Makers Conference in California. Over time, my observing skills have gradually improved, almost to the point of making me want to reobserve most of the objects on the list! Rather than do this though, I've settled into observing objects listed in other catalogs compiled by professional astronomers over the years.

As any seasoned traveler will tell you, this is what exploration is all about. As time passes, confidence grows along with ambition. What new objects wait to reveal their beauty? How far can a scope see on a clear night from the Rim? Whatever challenge awaits you, the main point is to take notes at the eyepiece. Whether your intent is to someday make a discovery or do a systematic survey of the sky or just to have fun, a log serves as silent testament to your growth into the stars and beyond. ☐

An avid deep-sky observer for 20 years, by day Tom Polakis engineers jet engines for Allied Signal in Phoenix, Arizona.

THE VANISHING RINGS OF SATURN

Backyard observers will see a starkly different Ringed Planet this year as the glorious rings turn edge-on and disappear from view.

by Julius Benton and Richard Talcott

No sight in a telescope fires the imagination more than that of Saturn. Its pale yellow globe encircled by resplendent rings has probably turned more people on to astronomy than any other telescopic object in the universe. And every backyard astronomer loves showing the planet off to neophytes so that they, too, can share in the beauty of the planet.

But not this year. For much of 1995, Saturn's magnificent rings will simply be invisible in small scopes, lost from view as they tip edge-on to our line of sight. And for most of the rest of the year, the rings will be no more than a razor-thin line extending along the planet's equator.

But that's not to say observers should steer clear of Saturn. Instead, they should take this rare opportunity to view a strikingly different Saturn. The nearly edge-on orientation of the rings gives viewers with larger telescopes a chance to glimpse faint components of the rings normally lost in the rings' glow. Saturn's inner satellites also appear most prominent around this time because glare from the rings doesn't overwhelm them. Finally, the planet's subtly banded globe becomes a tempting target itself with the competing rings now out of the way.

A 15-Year Wait

Saturn's rings appear edge-on this year because the Sun and Earth pass through the plane of the rings (which essentially coincides with the plane of Saturn's equator). What's happening isn't hard to understand if you compare Saturn with Earth. Each year, in March and September, an observer on Earth's equator sees the Sun directly overhead at noon. And midway between those dates the Sun lies farthest from the equator, with summer beginning in the Northern Hemisphere in June when the Sun appears farthest north of the equator and winter commencing in the Northern Hemisphere in December when the Sun reaches farthest south of the equator.

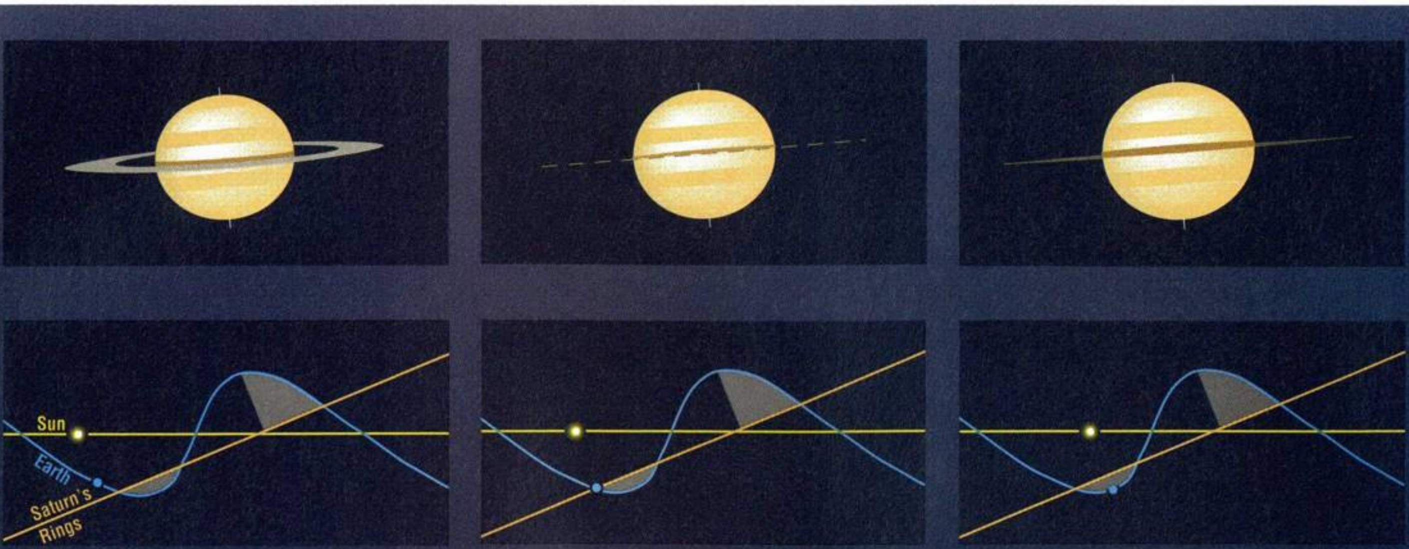
The situation on Saturn is similar. Its ring-plane tips nearly 27° relative to Saturn's orbit around the Sun while Earth's axis tilts 23.5° relative to its orbit. The chief difference is that Saturn takes 29.5 Earth years to orbit the Sun, so its seasons are drawn out much longer. But just as with Earth, twice each Saturnian year the noontime Sun stands directly over the planet's equator. The last time that happened was on March 3, 1980. Since then the planet's northern hemisphere has basked in the Sun's direct rays, with summer having arrived there on December 10, 1987. On that date, the Sun began its long trek back toward the Saturnian equator, which it will cross on November 19, 1995.

But that can't explain everything we'll see this year. Because Earth's orbit does not lie in the same plane as Saturn's orbit, the view from Earth becomes even more complex: We pass through Saturn's ring-plane *three* times, on May 22 and August 10, 1995, and again on February 11, 1996. That happens because, as seen from Saturn, Earth lies south of the Sun around the middle of the year. It thus dips south of the ring-plane and then comes back north while the Sun remains north of the ring-plane. By the time the Sun passes through the ring-plane in November, Earth lies north of the Sun, so it must pass through one more time.

The Five Aspects of Saturn

The three ring-plane crossings by Earth and one by the Sun yield five distinct aspects of the rings during 1995-96. The first began in late March, when Saturn first became visible in the morning sky, and continues until Earth's first ring-plane crossing on May 22. During this interval, both the Sun and Earth lie on the north side of the planet's rings, so we see the illuminated side of the rings as we have for the past 15 years. The only difference is that the rings are tilted just a few degrees to our line of sight (2.2° on April 1 shrinking to 0.8° by May 1) so they appear as little more than a ghostly line.

The first major test of your telescope and observing skill comes as May 22 approaches. The rings are very wide, about 170,000 miles across, but only about a mile thick. They are so thin, in fact, that the normally bright rings can't be seen at the exact moment of ring-plane crossing. So the question is, how close to ring-



MAY 1, 1995
SUN north of ring-plane
EARTH north of ring-plane

MAY 22, 1995
SUN north of ring-plane
EARTH in ring-plane

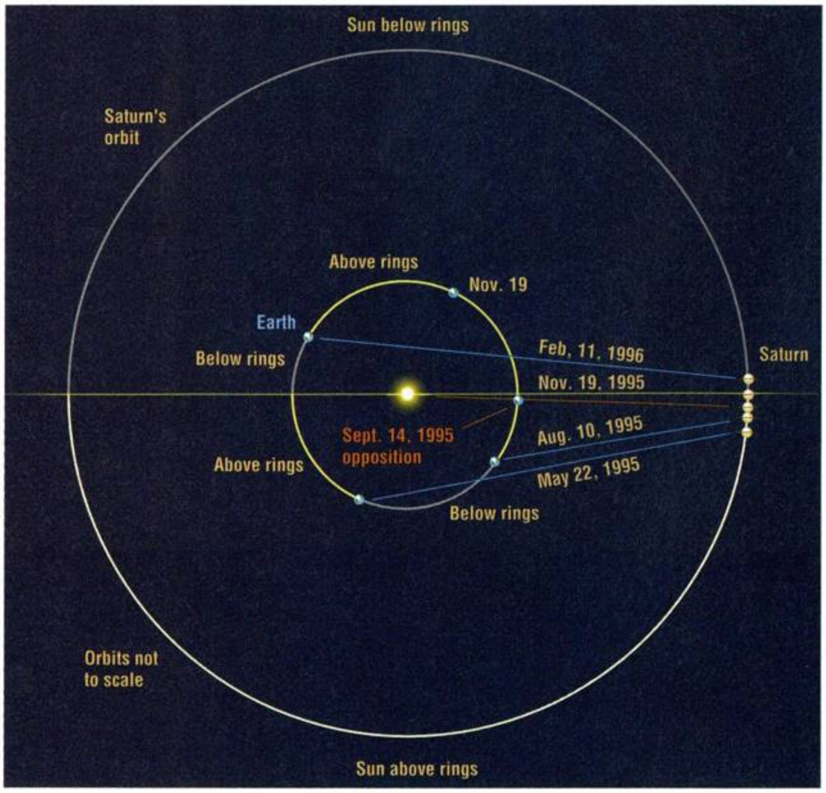
JULY 1, 1995
SUN north of ring-plane
EARTH south of ring-plane

plane crossing can you still see them? During the last ring-plane crossing in 1979-80, observers with 12- to 16-inch telescopes were able to spot the sunlit side of the ring system up to within a few days or even hours of ring-plane crossing. A smaller scope or poor observing conditions won't let you follow the rings this long.

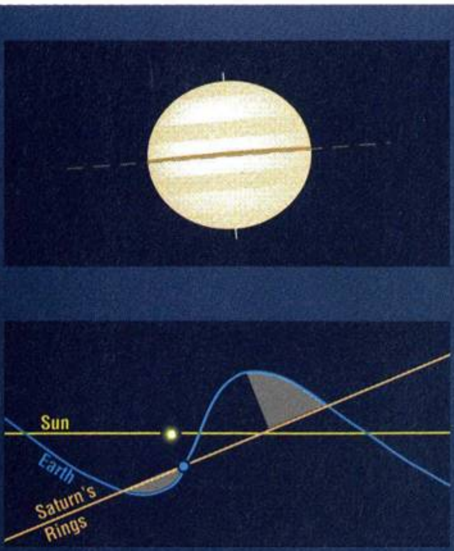
Common sense suggests that when Earth passes through the ring-plane on May 22, the rings will disappear from view. And that seems to be true, at least for the bright A and B rings and the inner C ring. But outside of the A ring lies a vast, dusky, and very tenuous ring called the E ring. Some observers claim to have glimpsed this elusive outer ring at previous edge-on orientations, when it would be easier to see because the competing glare from the other rings is absent. You might have a slim chance of spotting it at the eyepiece of a large backyard telescope and perhaps a better chance of recording it with a CCD camera.

Another thing to watch for at ring-plane crossing is the presence of any particles above or below the ring system. If these particles exist, as some Earth-based observations and Voyager data imply, the best time to detect them would be when the rings are turned edge-on. Any such particles probably would appear as a haze above or below the ring-plane, but observers should be extremely careful not to be fooled by the imposing glare of Saturn's globe, especially in less-than-perfect seeing.

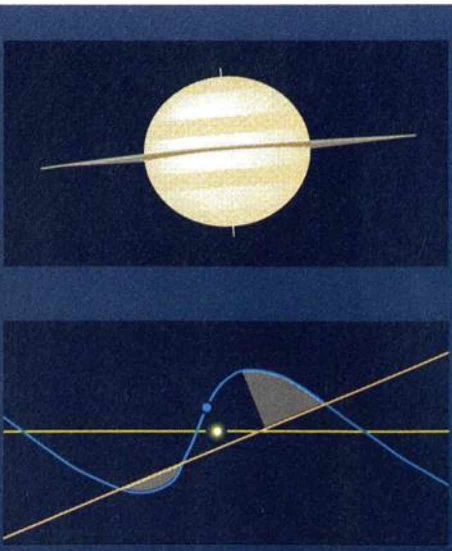
SATURN'S APPEARANCE WILL CHANGE continually over the coming year as both the Sun and Earth pass through the plane of the planet's rings. The series of eyepiece views (above and on the next two pages) shows what Saturn will look like in an inverting telescope having south at top. The companion diagrams display the paths of the Sun and Earth as seen from Saturn. Note that the rings seem to disappear when either the Sun or Earth is in the ring-plane and appear ghostly when the Sun and Earth lie on opposite sides of the rings, depicted by the gray shading. Only when the Sun and Earth lie on the same side of the rings do the rings resemble their familiar selves. These ring-plane crossings occur twice during each 29.5-year orbit of Saturn around the Sun (below).



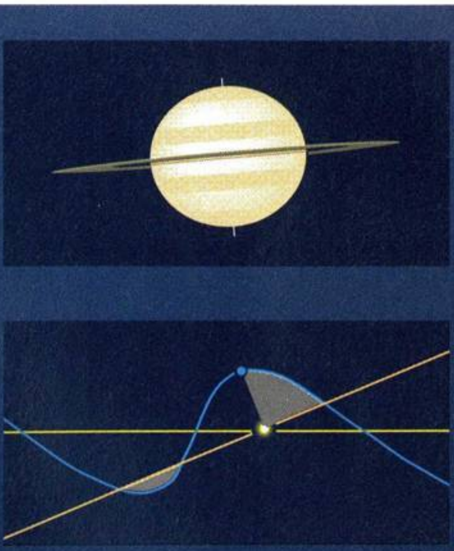
ASTRONOMY: Lee Vande Visse



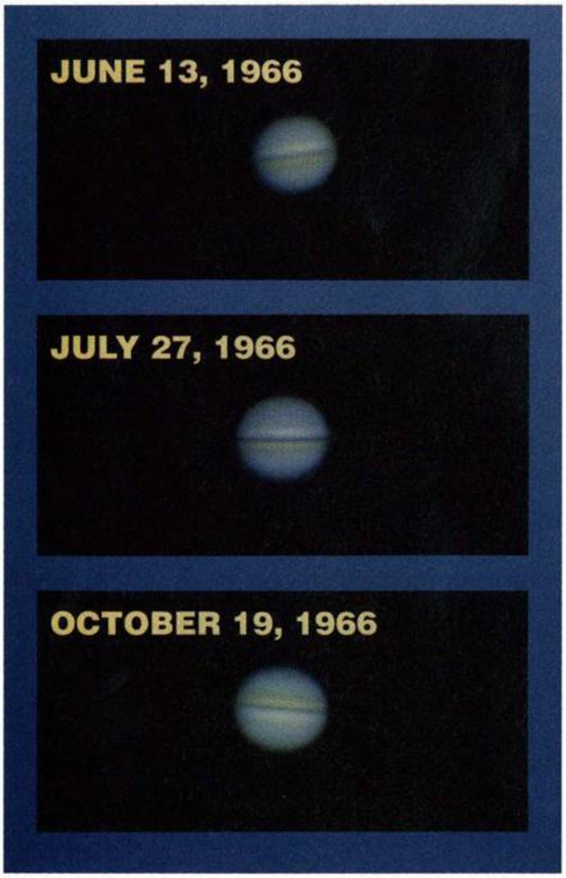
AUGUST 10, 1995
SUN north of ring-plane
EARTH in ring-plane



OCTOBER 1, 1995
SUN north of ring-plane
EARTH north of ring-plane



NOVEMBER 19, 1995
SUN in ring-plane
EARTH north of ring-plane



Charles Capen

THREE DIFFERENT VIEWS SHOW SATURN around the time of ring-plane crossing in 1966. The rings couldn't be photographed when the Sun lay in the ring-plane (top) or Earth did (bottom), but they showed faintly when both the Sun and Earth lay south of the ring-plane (middle).

On the Other Side

Following the May 22 ring-plane crossing, Earth lies south of the rings while the Sun remains north of them. We see the unilluminated southern face of the rings lit from behind by the Sun. If the rings were a solid sheet, they would be invisible at this time, but fortunately that's not the case.

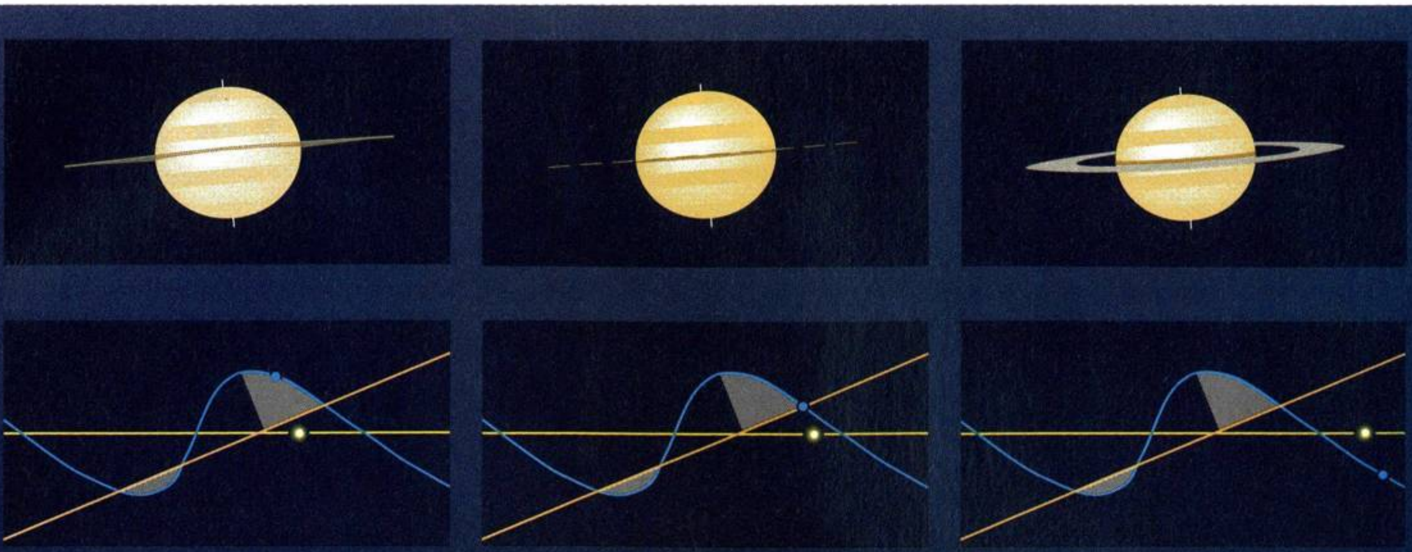
As images taken by the Voyager spacecraft showed so dramatically, sunlight filtering through the more tenuous parts of the ring system can make these regions appear fairly bright. In a small scope, you probably won't be able to see the rings at all until Earth passes back through the ring-plane in mid-August. But with a 12-inch or larger scope, you should be able to detect the rings again by several days to a few weeks after the May 22 ring-plane crossing. From our Earth-based perspective, the rings are tipped furthest to the south (–0.6°) on July 2, 1995.

Most observers notice that the brightest parts of the ring system, when viewed from the illuminated side, appear faintest when backlit, and vice versa. Thus the outer third of the B ring, normally the brightest component of the illuminated face of the rings, appears darkest when backlit, the A ring is somewhat brighter than the B, and the C ring appears brightest of all.

Another feature to look for in the rings when they are backlit is bright knots of light. Easiest to see near the time of ring-plane crossing, these knots apparently mark the regions of lowest density in the rings where the most sunlight filters through. Take care not to mistake a Saturnian satellite for one of these points of light. If present, satellites will also look like beads of light along the plane of the rings. Because of poor seeing conditions, the points of light often appear to twinkle, resulting in a beautiful and sometimes colorful spectacle. Observers should carefully note the position of such beads on any drawing, as well as the precise time they appear and their relative brightness.

Earth's second passage through the ring-plane comes on August 11, when our planet climbs to the north side of the rings. For a few months, Saturn's appearance returns to normal as both the Sun and Earth once again lie north of the ring-plane. When the planet reaches opposition on September 14, the rings will be tipped 1.2° to our line of sight.

The next milestone occurs on November 19, when the Sun finally passes through the ring-plane heading south. Even though the rings have opened up significantly from our point of view, being tipped then 2.7° to our line of sight, the rings once again disappear from view. The culprit this time is the Sun, which only illuminates the thin edge of the rings. With a 6-inch or larger telescope, you should be able to detect the rings up to the day of this crossing, which is easier to observe than any of Earth's ring-plane crossings.

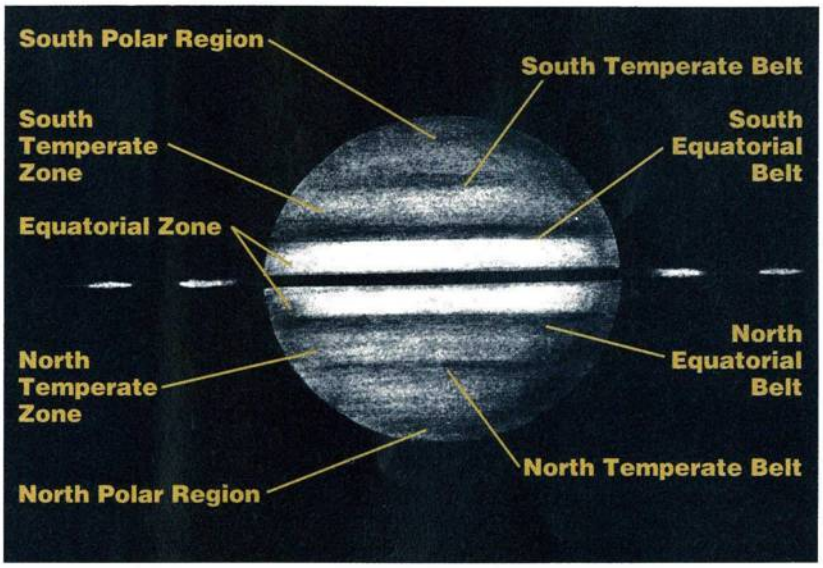


JANUARY 1, 1996
SUN south of ring-plane
EARTH north of ring-plane

FEBRUARY 11, 1996
SUN south of ring-plane
EARTH in ring-plane

MAY 1, 1996
SUN south of ring-plane
EARTH south of ring-plane

SATURN'S CLOUDTOPS STAND OUT when the rings turn edge-on and don't interfere with the view. This year offers observers a great opportunity to view the planet's subtle belts and zones.



E. E. Barnard

Following the Sun's passage south, Sun and Earth once again find themselves on opposite sides of the rings. That means observers with small scopes may once again be out of luck but those with large scopes can observe the backlit rings as 1995 winds to a close.

The final act of this five-part drama arrives on February 11, 1996, when Earth heads south through the ring-plane. As Earth joins the Sun on the south side, the illuminated south face of the rings will become visible. This final passage will be the hardest to observe because Saturn is then only a little more than a month away from solar conjunction, placing it low in the sky for observers everywhere.

Spot Yourself a Satellite

The changing aspect of the rings isn't the only thing to watch for this year on Saturn. Six of the planet's major satellites — Mimas, Enceladus, Tethys, Dione, Rhea, and Titan — orbit in virtually the same plane as the rings, so this year they often will be transiting, occulting, and eclipsing each other. Saturn's satellites will take on a different look even when no events are taking place, lining up in the plane of Saturn's equator like fainter versions of Jupiter's Galilean satellites. Because the satellite events are so varied and numerous, ASTRONOMY will devote a separate article to them in the September issue. You can also keep up with the ongoing events in the monthly Sky Almanac section.

Besides observing the rings and satellites of Saturn, viewers should take time to examine the planet itself. Although the belts and zones of Saturn's cloudtops appear subtler than those on Jupiter, some are quite easy to see even in small scopes. You can find a full description on observing Saturn in *The Saturn Handbook*, published by the Saturn Section of the Association of Lunar and Planetary Observers. People interested in following Saturn and its rings during this exciting year can contact Julius Benton at the address below for suggestions and guidance as well as standardized forms and drawing blanks.

Whether you decide to record your observations or just sit back and enjoy the view, don't pass Saturn by this year. You won't have another chance to see the Ringed Planet without its rings until the summer of 2009. ☐

Julius Benton (Associates in Astronomy, 305 Surrey Road, Savannah, GA 31410) is Recorder for the Saturn Section of the Association of Lunar and Planetary Observers.

Blasting

Along the InfoBahn

Here's a guide to some of the great destinations on the Information Superhighway for armchair and backyard astronomers plus some info on finding a local on-ramp.

by David Bruning

Riding the Information Superhighway. Navigating the Web. Surfing the Net.

These phrases refer to the Internet, a vast network of computers around the world linked by phone lines. References to the Internet in papers and magazines have become commonplace but the average North American still thinks access to it is limited to universities or that it's way too expensive for private users. Well, the Internet is here, anyone can access it, and it doesn't cost a fortune. Better yet, lots of resources for armchair and backyard astronomers are on the Internet just for the taking.

The Internet is the passageway to catching the latest news from the Hubble Space Telescope, finding images of Comet Shoemaker-Levy 9 and the impacts of its fragments on Jupiter, downloading astronomical software, corresponding with friends through electronic mail (e-mail), trading questions and answers with backyard and professional astronomers around the world, exploring the latest catalogs of astronomical objects, touring an observatory half a continent away, and learning about the latest sky events and discoveries of comets and supernovae.

The first step to accessing all the great astronomy places on the Internet is getting a computer. It doesn't matter whether it's a PC (running Windows) or Mac, but be sure it has at least 8 megabytes of memory. A color monitor is nice for looking at color images, and a hard disk is essential for downloading large images and files you find on the Internet.

The second step to getting on the network is to contact an Internet provider. Whereas most universities and large companies tie directly into the Internet, individual users usually rent a connection to the network through a provider.

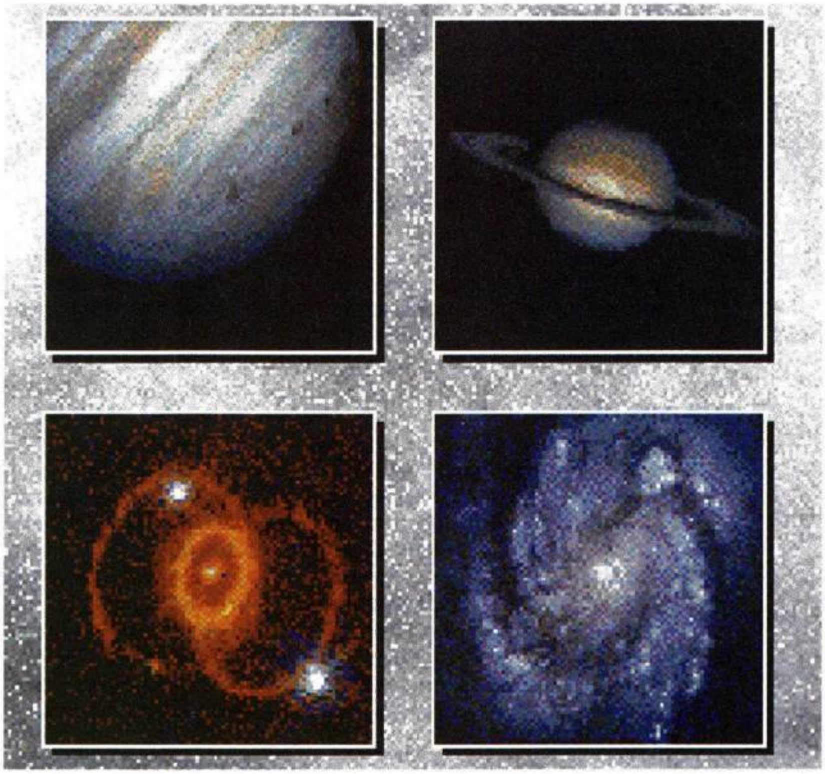
All illustrations by Greg Kot

Getting On

Four main routes exist for connecting to an Internet provider: on-line computer services, Internet shells, SLIP/PPP connections, and direct connections. On-line services, Internet shells, and SLIP/PPP connections cost about the same while direct connections can be quite expensive.

On-line computer services, such as CompuServe and Delphi, have a computer tied into the Internet. You then dial into the service's computer via a modem to link into the Internet. A modem converts the 1's and 0's of computer data into beeps and chirps transmitted by phone lines. Many on-line services provide limited access to the Internet, offering perhaps just e-mail and simple file transfer. Often these providers require that you use their software to access their services and the Internet.

Shells turn your computer into a terminal (just a keyboard and display) tied to the provider's computer. Some providers call this terminal emulation. A modem links your computer to that of the provider. Some shells use standard communications programs to run the modem; others use programs written especially for the provider's company. The Internet

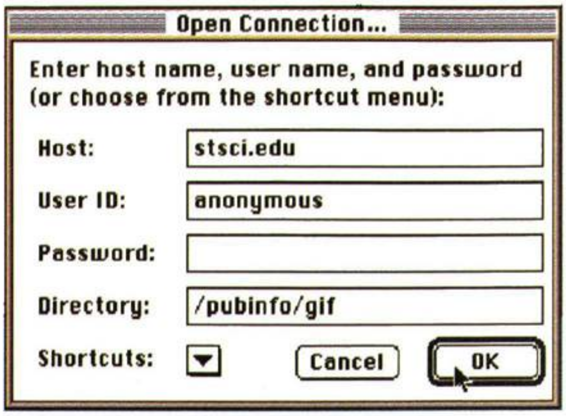


CATCH THE LATEST IMAGES from the Hubble Space Telescope from Hubble's home page on the Web.

services offered by many shells are limited.

SLIP/PPP (serial line Internet protocol/point-to-point protocol) connections again tie your computer by modem to the provider's. But now your computer becomes part of the network. This method is faster than the on-line service and shell routes. This connection usually furnishes complete access to the Internet — e-mail, file transfer, access to the World Wide Web, Internet information searches, and remote connections into other computers.

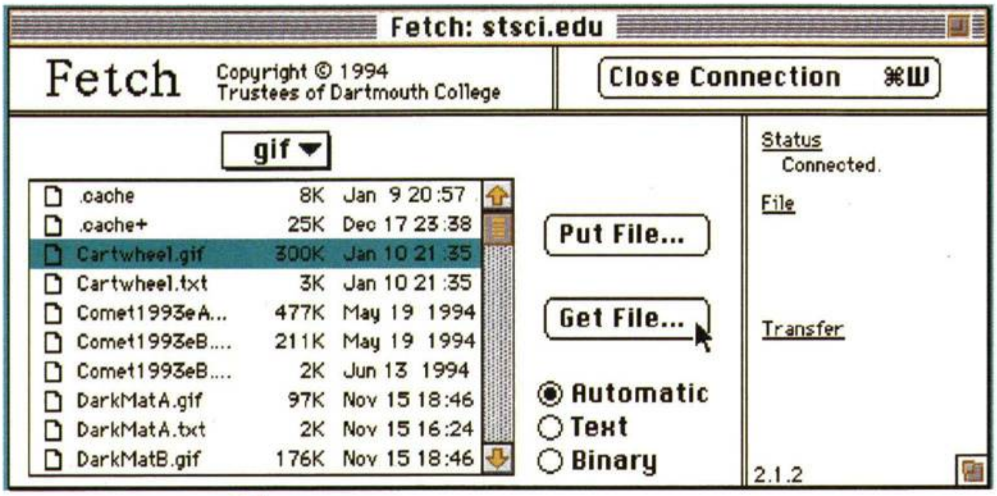
Direct connection to the Internet is the top-of-the-line. A user's computer ties directly via a dedicated phone line (without modems) into the computer network. Direct connection is blazingly fast compared with modems, and it offers complete access to the Internet.



Open Connection...

Enter host name, user name, and password (or choose from the shortcut menu):

Host: stsci.edu
User ID: anonymous
Password:
Directory: /pubinfo/gif



Fetch: stsci.edu

Fetch Copyright © 1994 Trustees of Dartmouth College

.cache	8K	Jan 9 20:57
.cache+	25K	Dec 17 23:38
Cartwheel.gif	300K	Jan 10 21:35
Cartwheel.txt	3K	Jan 10 21:35
Comet1993eA...	477K	May 19 1994
Comet1993eB....	211K	May 19 1994
Comet1993eB....	2K	Jun 13 1994
DarkMatA.gif	97K	Nov 15 18:46
DarkMatA.txt	2K	Nov 15 16:24
DarkMatB.gif	176K	Nov 15 18:46

Status Connected.

● Automatic
○ Text
○ Binary

TRANSFERRING IMAGE FILES from the Hubble Space Telescope is easy with a file transfer program such as *Fetch* for the Mac.

Modem speed is important because blasting along the infobahn is a relative term. A 2,400-bit-per-second modem will transfer a 1 megabyte file in one hour (8 bits make a byte, one byte is equivalent to a character). A 14,400 bps modem will transfer the same file in about 10 minutes. Users lucky enough to use a dedicated phone line (1,540,000 bps), called a T1 line by the phone company, can grab the file in 10 seconds. Of course, the actual time needed to transfer the file will be longer than any of these times because users share the Internet with tens of thousands of others. Competing use (especially during prime business hours) and error checking and correcting (done automatically for every bunch of data bits transmitted over the network) can increase the actual transfer time by up to 10 times.

For full Internet access, use a modem with a speed of at least 14,400 bps. On-line services and shells may support speeds of only 9,600 bps so check with the provider before buying a faster modem.

Choosing a Provider

Hundreds of Internet providers exist, from nationwide corporations to local companies. Selecting one is like buying a computer: You need to consider convenience, speed, ease of use, and service, in case something goes wrong.

On-line computer services may be attractive if you already subscribe to such a service for electronic shopping, stock market quotes, and user

What Is the Internet?

The Internet is a collection of thousands of local, regional, and global Internet Protocol networks. What it means in practical terms is that millions of computers in schools, universities, corporations, and other organizations are tied together via telephone lines. The Internet enables users to share files, search for information, send electronic mail, and log onto remote computers. But it isn't a program or even a particular computer resource. It remains only a means to link computer users together.

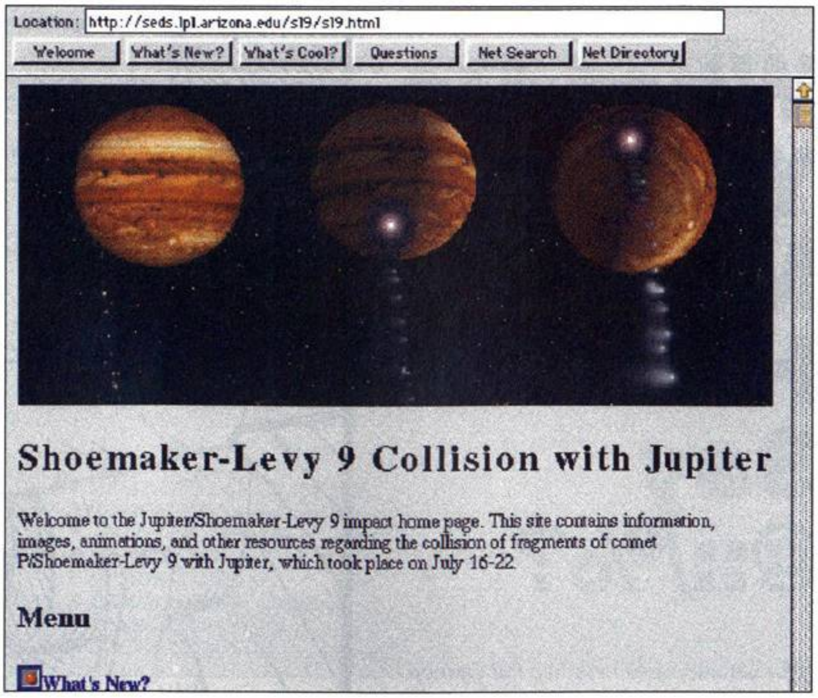
Unlike on-line computer services such as CompuServe and America On Line, no one runs the Internet. Rather a group of people called the Internet Society sets various rules that govern how computers on the network should talk to one another. Being good Internet citizens is an honor system for now, but a series of basic rules has arisen through use (see Internet Dos and Don'ts).

No one pays for the Internet because the network itself doesn't exist as a separate entity. Instead various universities and organizations pay for the dedicated lines linking their computers. Individual users may pay an Internet provider for access to the Internet via its server. So even though the Internet provides free access to many computers, it may cost money to use it. And free access may change as the National Science Foundation, NASA, and other federal agency budgets decline in the future.

forums. Nationwide providers often offer trouble-free lines and polished software packages. Local providers can offer personalized service and competitive rates. When checking out a provider, ask if they have a free trial period or, in the case of a local company, can demonstrate their programs and services in their office.

Check the speed of the provider's line into the Internet: They should have a T1 dedicated line. Also check their traffic volume and how many modems users must share. If they have a small number of incoming lines (or modems) per subscriber, you'll spend more time listening to busy signals than cruising the Internet. A nicety, although by no means a mandatory feature, is a second computer and T1 line. If something goes wrong with one system, the provider just connects subscribers to the other system without interrupting Internet service.

When looking at price, don't forget to factor in telephone charges.



Shoemaker-Levy 9 Collision with Jupiter

Welcome to the Jupiter/Shoemaker-Levy 9 impact home page. This site contains information, images, animations, and other resources regarding the collision of fragments of comet P/Shoemaker-Levy 9 with Jupiter, which took place on July 16-22.

Menu

What's New?

CHECK OUT THE ANIMATIONS of the great comet crash stored on the home page of the Students for the Exploration and Development of Space.

Who's Archie?

archie: a service that locates file names on a computer. It has limited ability to search by topic. Originally searched only ftp archives.

Cello: a Windows-based program for browsing resources on the Internet.

FAQs: Frequently Asked Questions; posted on home pages and in newsgroups and Usenets for use by beginners. Don't post a question until you check the FAQs.

ftp: file transfer protocol and file transfer program; a means for transferring a program from one computer to another.

Gopher: a finder that locates resources by searching menu lists on other computers.

home page: a graphical menu that enables Web browsers to access information on a server.

html: hypertext mark-up language; a set of standard words that enables Web programs to display home pages and other Web documents.

Mosaic: a popular program for browsing the Internet. Available free for Macs, PCs, and Unix-based computers.

newsgroup: a bulletin board on the Internet similar to discussion forums on on-line computer services. Hundreds of special interest groups have newsgroups.

POP: Post Office Protocol; a method for reading e-mail from a server.

server: a computer directly tied to the Internet. A user's computer may be either the server itself or networked to the server.

SLIP/PPP: Serial Line Internet Protocol/Point-to-Point Protocol; methods for connecting a computer via modem to a server.

telnet: a program that enables a user to log onto a remote computer and use its software. Often needed to check out library holdings.

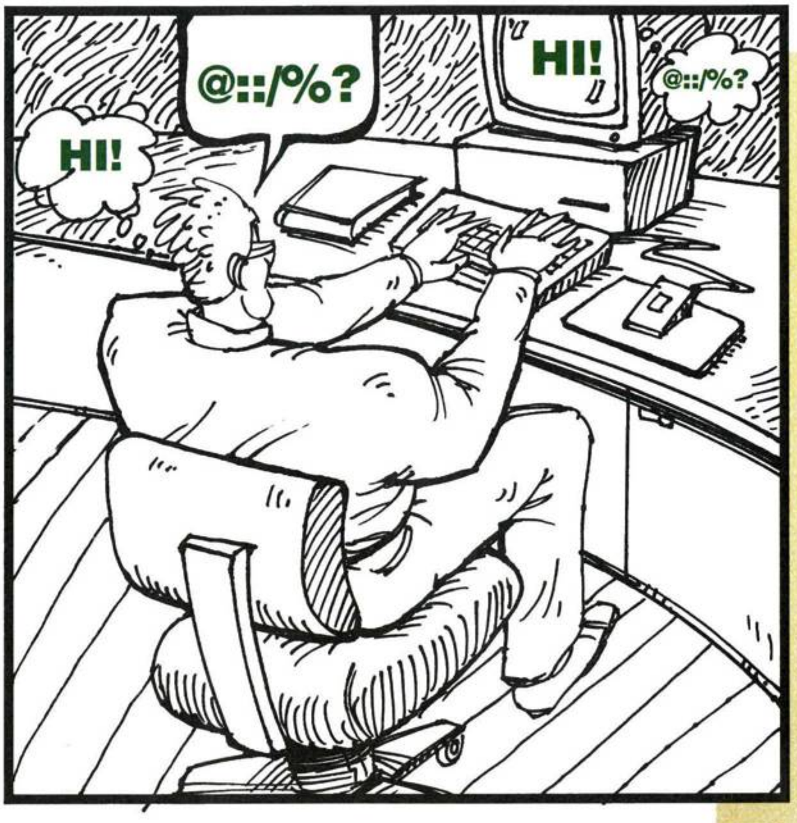
TCP/IP: Transmission Control Protocol/Internet Protocol; TCP is the method by which computers send data to one another over dedicated telephone wires. IP is a method of addressing so routed information knows where to go.

URL: Uniform Resource Locator; an address that lets programs find a resource, identify how to access the resource, and interpret the contents properly as text, image, or audio information.

veronica: a Gopher-based program like archie for finding files on Gopher servers.

World Wide Web: a collection of documents on the Internet that have address pointers (URLs) embedded in them to link users automatically to other Internet documents. Called the Web for short, it's the best way to travel the Internet.

What Do You Mean I Have to Say @::/%?



E-mail addresses look like the cartoon device used to depict swearing. In the early days, users often had to send e-mail through special routes, requiring the invocation of mysterious names and curious characters. Not knowing the correct way to list someone's address often caused the sender to orally invoke the same characters.

Nowadays things are easier. E-mail addresses make more sense, although beginners still require a decoder ring. Most addresses today use the form **username@domain**. The domain is actually a computer address and technically uses a series of numbers to tell other computers where it is and how to connect to it. Thankfully, the domain is given an alias. For example, all commercial users of the Internet are in the domain **com**. Educational users in **edu**, organizations in **org**, and computer networks in **net**. Countries also have separate domains, such as **ca** for Canada, **fr** for France, and **au** for Australia.

These top-level domains aren't enough to get you to particular users. For that, you also need to know their subdomain. For example, ASTRONOMY's computer subdomain is astronomy; the full domain is **astronomy.com**. Sometimes you can guess at a domain name; for example, the Space Telescope Science Institute (abbreviated STScI) has a domain of **stsci.edu**. Other times the names are abbreviated or nicknames are used in the domain. In those cases, look up the domain name in a guide such as *!%@:: A Directory of Electronic Mail Addressing and Networks* (O'Reilly and Associates, Inc., 1994).

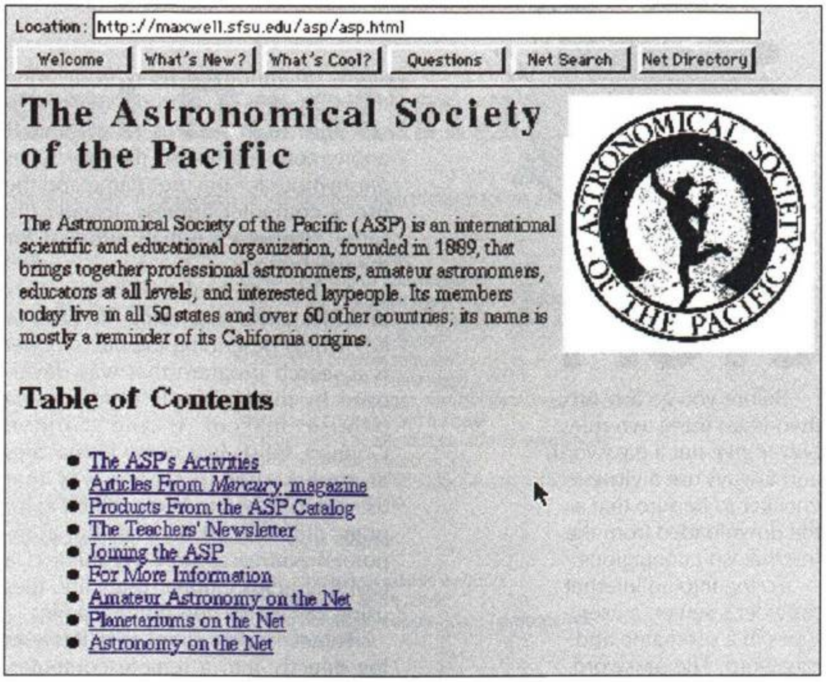
Unfortunately, user names can be just about anything. Many systems use first initial and last name in one word, but other systems use initials, nicknames, abbreviated names, numbers, or combinations of numbers and names. For example, ASTRONOMY's CompuServe address on the Internet is **72000.2704@compuserve.com**. If user names aren't confusing enough, individual systems may use a combination of user-name styles. And some networks such as JANET reverse the order in the domain so **uk.ac.univ.ast** is really **ast.univ.ac.uk** for Internet users. It's simple to recognize an inverted domain because the country code (**uk** in this case) or organization code (**gov**, **org**, **edu**, **etc**.) should be last.

The simplest way to find out a user name is to call the person and ask for it. He or she may not know the Internet address so just ask for an e-mail message to be sent to your address. The person's address will be in the "From:" part of the message.

Of course, you may not know the person's phone number, so then what? Luckily, help exists on the computer itself. Various organizations have "phone book" listings of their e-mail users; these are available via ftp from the organization's home computer (sometimes on the home page if you use the Web). Often Internet access programs include a program called *netfind* that can search lists of users at thousands of Internet sites. Unix users can use finger: If you know the computer domain, try **finger @domain | more**. *Whois*, *ph*, and *uwho* are other programs that can help you find the person's e-mail address. Once you get that address, write it down on something more durable than the back of an old envelope.

A lot of astronomy clubs have bulletin boards connected through FidoNet. A user on FidoNet has an address like **User.Name@zone:net/node** (for example, **John.Smith@1:111/222**). Send e-mail to this user at **User.Name@f**(node)**.n**(net)**.z**(zone)**. fidonet .org** (for example, **John.Smith@f222.n111.z1. fidonet .org**).

One final admonition: Be careful with lower- and uppercase letters. UNIX-based computers, which make up a great fraction of the computers connected to the Internet, are case sensitive, meaning that they recognize jsmith, JSMITH, and JSmith as three different user names. The convention is to give your address as lowercase letters unless your home computer requires that certain letters be capitalized.



Location: http://maxwell.sfsu.edu/asp/asp.html

The Astronomical Society of the Pacific

The Astronomical Society of the Pacific (ASP) is an international scientific and educational organization, founded in 1889, that brings together professional astronomers, amateur astronomers, educators at all levels, and interested laypeople. Its members today live in all 50 states and over 60 other countries; its name is mostly a reminder of its California origins.

Table of Contents

- The ASP's Activities
- Articles From *Mercury* magazine
- Products From the ASP Catalog
- The Teachers' Newsletter
- Joining the ASP
- For More Information
- Amateur Astronomy on the Net
- Planetariums on the Net
- Astronomy on the Net

CLUBS, PLANETARIA, AND ASTRONOMY ON THE NET are features of the Astronomical Society of the Pacific's home page. Web visitor's can also examine the ASP's catalog of astronomical products, articles from *Mercury* magazine, and other Internet resources about astronomy.

Some providers require long-distance phone calls to their network or charge connection fees in addition to the hourly usage rates. The connection fees sometimes apply even though the provider has a local phone number for users: They bill users for the phone charge to connect to their computer in another state. So the base rate may be cheap but the phone bill may kill any interest in the Internet.

I'm On — Now What?

A provider will probably give a bunch of programs for e-mail, ftp, Gopher, archie (and maybe his friends, jughead and veronica), and lots of other cryptic things. (They may provide shareware: See the note below.) These programs enable users to access the Internet in different ways.

For example, you might get a popular program for sending electronic mail called *Eudora.* E-mail is probably the single most widely used Internet tool. Writing e-mail is no trickier than typing a letter in a word processing program. The hard part is figuring out a person's e-mail address (see What Do You Mean I Have to Say @::/%?).

E-mail serves as the foundation for another Internet resource, mailing lists. Special interest groups often have a newsletter available to subscribers (usually free) via e-mail. Subscribing is as simple as sending a message to the list address with the text reading SUBSCRIBE mailing-list-name your-first-name your-last-name.

Ftp (file transfer program) enables you to transfer, or download, text files and programs from any computer on the Internet to yours. A common ftp program is called *Fetch.*

To download a program, you start the ftp program and then enter the address for the computer holding the program. The ftp program then connects you to the remote computer. Next the computer asks for a user name and password, which

Internet Dos and Don'ts

Because no one runs the Internet, no one controls what happens on it. But that doesn't mean anarchy reigns. Common courtesy is the rule of the day and users have developed guidelines called netiquette to keep interactions civilized. Be considerate in your use of network resources. Forgetting to log off a computer can prevent someone else from logging in. Poorly thought-out searches can slow system response time, affecting other users.

Be courteous. Recipients of e-mail messages don't hear your tone of voice. Your simple response may be perceived as being rude by another user, so construct messages carefully.

Observe posted rules. Many systems display these in a log-in banner or in a section listed in Terms and Conditions or Usage Policy.

Pay attention to copyrights and fair use agreements. Material on the network is not necessarily free for the taking. Much of it can be downloaded freely, as long as you obey applicable copyright notices. Some of it though is not for recirculation even if you can download it. Remember: Shareware isn't free. Users usually get a 30-day period to try the software for free; after that, they must pay for its use.

Check for a FAQ list (frequently asked questions) when starting out in a newsgroup or usegroup. Many questions will be answered there. Checking for an answer before posting an often-asked question will prevent the ire of veteran users.

Don't interfere with network users, services, or equipment by mailing unsolicited advertising, sending chain letters, or trying to make an unauthorized entry to any computer. Don't use the network to transmit threatening, obscene, or harassing materials.

The Internet forbids advertising of commercial offerings but users may discuss freely a product's relative advantages and disadvantages. Vendors may respond to questions about their products but responses can't be ads.

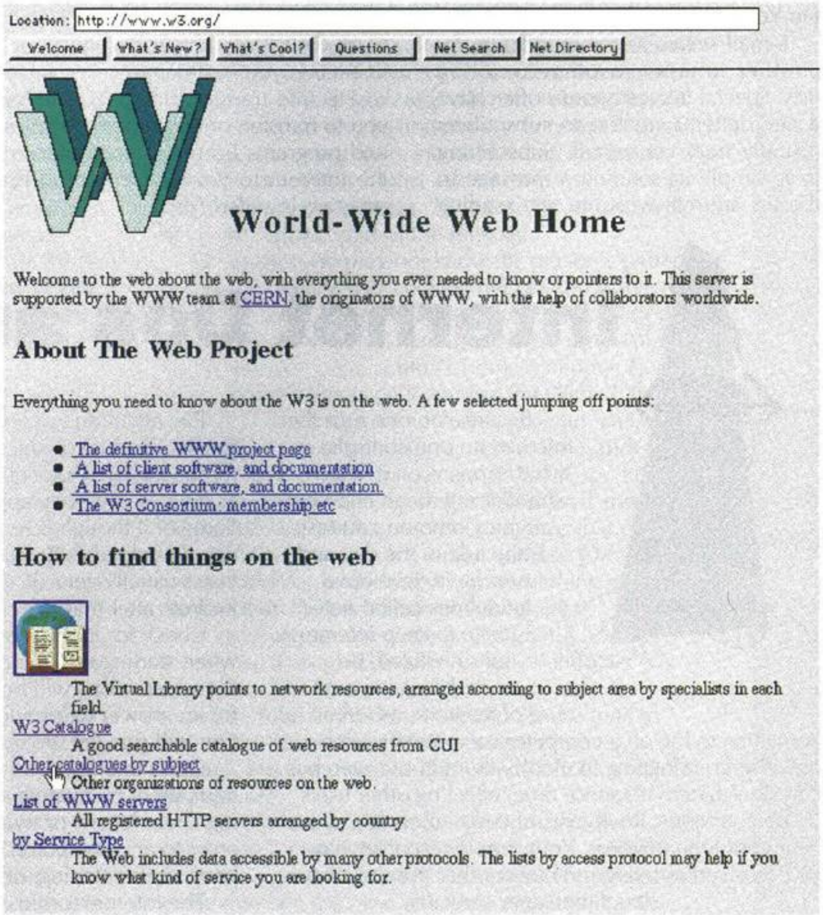
keeps unauthorized users from using the computer. Most computers accessible through ftp (ftp sites) permit anonymous log-ins, so the user types *anonymous* for the user name and the user's computer address (usually the same as a user's e-mail address) for the password.

Archie is a tool that helps users find files at ftp sites using file titles or key words describing the file. *Gopher* is a search program that was developed by the University of Minnesota (whose mascot is the Golden Gopher). It lists in a menu format files at gopher sites in such a way that users don't need to know which computer they are on or what the computers' addresses are. Veronica is a tool that helps Gopher users find files using key words describing the files.

Telnet is a program that lets you log directly into a remote computer. The most common use of telnet is to check the card catalog of a library and examine its database of periodicals. Sometimes you can log into a telnet site as *anonymous*, but often you must have a registered user name and password for that computer. That prevents unwanted users from getting into the computer system.

Usenet is a service accessed by a program called a newsreader. Usenet functions as a bulletin board with users posting messages and reading others' messages in a newsgroup. Thousands of newsgroups exist, from local ones provided by Internet providers to nationwide groups that explore science, hobbies, current events, medieval history, you name it.

These Internet tools are available in many versions as either freeware or shareware. Freeware is just as it says — free. But shareware isn't free; it's usually offered by program developers so users can try the program. You usually get a 30-day period to use the software free. If you like it, you pay a registration fee to purchase the license to continue using the program.



World-Wide Web Home

Welcome to the web about the web, with everything you ever needed to know or pointers to it. This server is supported by the WWW team at CERN, the originators of WWW, with the help of collaborators worldwide.

About The Web Project

Everything you need to know about the W3 is on the web. A few selected jumping off points:

- The definitive WWW project page
- A list of client software, and documentation
- A list of server software, and documentation.
- The W3 Consortium: membership etc

How to find things on the web

The Virtual Library points to network resources, arranged according to subject area by specialists in each field.

W3 Catalogue
A good searchable catalogue of web resources from CUI

Other catalogues by subject
Other organizations of resources on the web.

List of WWW servers
All registered HTTP servers arranged by country

by Service Type
The Web includes data accessible by many other protocols. The lists by access protocol may help if you know what kind of service you are looking for.

THE MOTHER OF ALL HOME PAGES. CERN, Europe's high-energy physics laboratory, produces the main home page for the World Wide Web of Internet resources. Clicking on Other catalogues by subject will display a listing of subject areas on the Web, such as astronomy.

STOP!

Before you go any further, learn these two rules: Never give out a password, and always use a virus checker to be sure that a file downloaded from the Internet isn't contagious.

To log into an Internet provider's server, a user types in a username and password. The password prevents unauthorized persons from getting into a computer system and reading confidential information or deleting files.

Computer hackers usually get into systems through users' passwords. Either the password is too simple or it hasn't been changed often enough. Sometimes the user has given it out to friends through e-mail and a hacker has intercepted it.

The password should have at least six different letters, contain at least one uppercase letter (not including the first and not be all uppercase), and use at least one number or special character. That gives over 100 billion different possibilities, making the password tough to crack. Don't use something obvious. Tony Smith shouldn't use TSmith, for example.

Don't get attached to that password: Change it often. And make it a meaningful one. Changing from Smith1 to Smith2 won't stop a hacker.

A good investment is a virus checker. Most files on the Internet are okay but a few contain viruses. Because there's no way to know which is which, check all downloaded files.

Great Destinations

FTP

Use a file transfer program to access these computer sites. Type in the name of the directory or use the ftp program to search for the directory.

Host computer	Directory	# Contents
archive.afit.af.mil	/pub/space	Satellite orbital elements
chara.gsu.edu	/	Saguaro Astronomy Club newsletter
delcano.mit.edu	/	Radar images, Magellan Hypermap (for Macintosh)
explorer.arc.nasa.gov	/cdrom and /pub	Magellan, Viking, Voyager CD-ROMs; news, and images
fatty.law.cornell.edu	/pub/LII/Cello	Cello Web browser software
ftp.ncsa.uiuc.edu	/	Mosaic Web browser software
ftp.sunspot.noao.edu	/pub	Solar activity, daily corona maps
ftp.uleth.ca	/pub/solar	Solar reports and images, auroral forecasts and updates
io.cc.gettysburg.edu (or try 138.234.4.10)	/pub	Educational programs and material
jplinfo.jpl.nasa.gov	/pub	Jet Propulsion Lab information, images, space news
kilroy.jpl.nasa.gov	/pub/space	Satellite elements, spacecraft info
nssdca.gsfc.nasa.gov	/	HST, IUE, Astro-1, COBE, NSSDCA info, FITS standard
pomona.claremont.edu	astro/catalog/yale_bsc	Yale Bright Star Catalog
pulsar.princeton.edu	/pub/catalog	Pulsar catalog
rigel.acs.oakland.edu	/pub/msdos/astronomy	PC computer software
satftp.soest.hawaii.edu	/pub	Earth images
seds.lpl.arizona.edu	/pub	images, animations, satellite elements
spacelink.msfc.nasa.gov	/	NASA Spacelink, NASA news
stsci.edu	/epa and /software	HSTMap (for Macs), Hubble Space Telescope info
sumex.stanford.edu	/info-mac/app	Macintosh software

World Wide Web

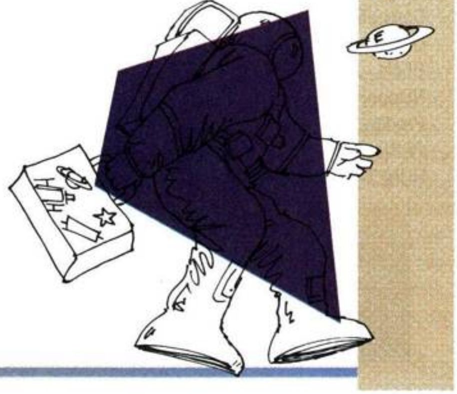
Use a Web browser such as *Mosaic* or *Netscape* to access these resource locations.

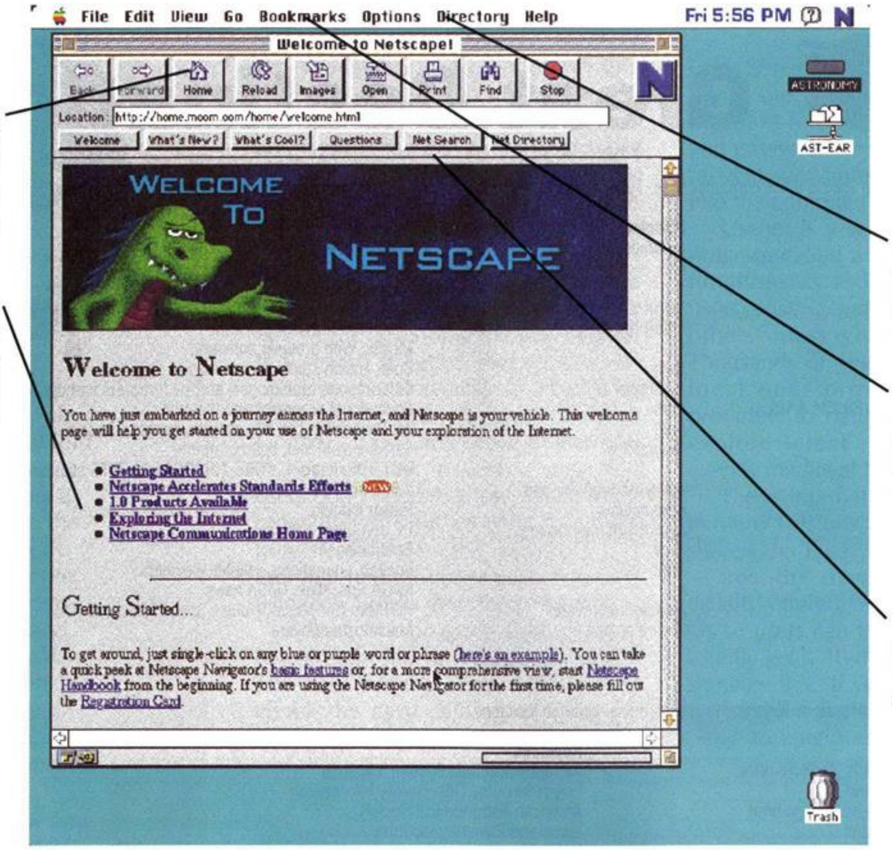
Uniform Resource Locator	Resource
http://adswww.harvard.edu/ads_services.html	Astrophysical Data System; catalogs
http://airsci-www.arc.nasa.gov/	Kuiper Airborne Observatory information
http://blackhole.aas.org/AAS-homepage.html	American Astronomical Society
http://cass.jsc.nasa.gov/lpi.html	Lunar and Planetary Institute
http://cdwings.jpl.nasa.gov/PDS/	NASA Planetary Imaging
http://cfa-www.harvard.edu/~graff/nelpag.ntml	New England Light Pollution Advisory Group
http://dorothy.as.arizona.edu:8008/soard/	Asteroid database
http://fits.cv.nrao.edu/www/astronomy.html	Astro Web (index of astronomical resources)
http://hypatia.gfsc.nasa.gov/NASA_homepage.html	NASA Information Sources
http://info.cern.ch	Mother of all WWW home pages
http://lcweb.loc.gov/homepage/lchp.html	Library of Congress
http://marvel.stsci.edu/net-resources.html	Astro Web (index of astronomical resources)
http://meteor.anu.edu.au/~pjq/macho.html	MACHO project (search for dark matter)
http://newproducts.jpl.nasa.gov/sl9/sl9.html	Comet Shoemaker-Levy 9 images
http://nssdc.gsfc.nasa.gov/	Astronomical catalogs
http://pdssbn.astro.umd.edu/home.html	Small Solar System Bodies
http://ringside.arc.nasa.gov/	Planetary Rings
http://seds.lpl.arizona.edu/sl9/sl9.html	Comet Shoemaker-Levy 9 images
http://spacelink.msfc.nasa.gov	NASA's Spacelink for news and images
http://stardust.jpl.nasa.gov/pds_home.html	Planetary Data Systems
http://umbra.gsfc.nasa.gov/sdac.html	Solar eclipse bulletins
http://www.apo.nmsu.edu/	Apache Point Observatory
http://www.astrouw.edu.pl/index.html	OGLE project (search for dark matter)
http://www.cea.berkeley.edu/HomePage.html	EUVE (extreme ultraviolet) satellite information
http://www.exploratorium.edu	San Francisco's Exploratorium
http://www.gemini.edu	8-meter Gemini Scopes
http://www.gettysburg.edu/project/physics/clea/CLEAhome.html	Lab exercises in astronomy
http://www.gsfc.nasa.gov	NASA home page
http://www.gsfc.nasa.gov/astro/cobe/cobe_home.html	COBE satellite products
http://www.gsfc.nasa.gov/hqpao/newsroom.html	NASA news releases
http://www.ifa.hawaii.edu/mko/mko.html	Mauna Kea observatories
http://www.jpl.nasa.gov/	Jet Propulsion Lab home page
http://www.jpl.nasa.gov/galileo.html	Galileo spacecraft
http://www.ncsa.uiuc.edu/General/NCSAExhibits.html	Cosmology images and animations
http://www.noao.edu/noao.html	National Optical Astronomy Observatories
http://www.physics.sfsu.edu/asp/asp.html	Astronomical Society of the Pacific
http://www.stsci.edu	Space Telescope Information Service
http://www.stsci.edu/exined-html/exined-home.html	Hypercard books for Macintosh
http://www.stsci.edu/EPA/Recent.html	Recent Hubble Space Telescope results
http://www.uni-sw.gwdg.de/HET/HET.html	Hobby-Eberly Telescope

Newsgroups

Use a newsreader to access these Usenet discussion groups.

sci.astro
sci.astro.fits
sci.astro.hubble
sci.astro.planetarium
sci.astro.research
sci.image.processing
sci.optics
sci.space
sci.space.news
sci.space.policy
sci.space.shuttle
sci.space.tech





Welcome to Netscape

You have just embarked on a journey across the Internet, and Netscape is your vehicle. This welcome page will help you get started on your use of Netscape and your exploration of the Internet.

- Getting Started
- Netscape Accelerates Standards Efforts
- 1.0 Products Available
- Exploring the Internet
- Netscape Communications Home Page

Getting Started...

To get around, just single-click on any blue or purple word or phrase (here's an example). You can take a quick peek at Netscape Navigator's basic features or, for a more comprehensive view, start Netscape Handbook from the beginning. If you are using the Netscape Navigator for the first time, please fill out the Registration Card.

When lost on the Web, just hit home to get back to your starting screen.

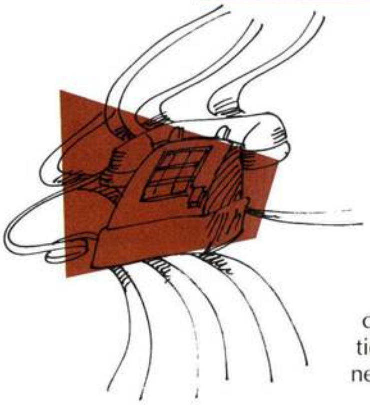
The purple type indicates you have explored this area of the Web already.

Don't know someone's e-mail address? Look here.

These save the locations of your favorite places on the Web.

Finding resources on the Web is easy with these search programs.

NETSCAPE IS A POPULAR WEB BROWSER for Macs and PCs. Clicking on the colored or underlined type links you automatically to other Web resources.



On-Ramps to the Internet

Lots of options exist for getting connected to the Internet. Sometimes the computer department of a local college or university will provide connections for a fee. On-line computer services either have or will soon have Internet capability (see the partial list of nationwide providers below).

Many companies are springing up across the country with Internet connectivity for private users. Check at your local computer store to find out if a local Internet provider is available. *The Internet Directory* (Fawcett Columbine, 1994) and other books list Internet providers by region. Some of the Internet books include software for connecting and a phone number for one or more Internet providers. Be careful: Connecting to some companies requires long-distance phone calls whereas connecting to others may be through local phone numbers or a toll-free number.

Company	Phone	Start-up Cost	Monthly Fee	Free Hours	Hourly Charge	Internet Capability
America Online	(800) 827-6364	$9.95		5	$3.50	news, e-mail, gopher
CERFNet	(800) 876-2373	$50.00	$20.00		$5 (M-F)	all
CompuServe	(800) 848-8199		$9.95		$4.80	ftp and e-mail
Delphi	(800) 544-4005	$19.00	$20.00	20	$1.80	all
GEnie	(800) 638-9636		$8.95		$18.50	archie, news, ftp
Netcom	(800) 501-8649	$20.00	$17.50		unlimited	all
Prodigy	(800) 776-3449		$14.95	2	$3.60	news and e-mail
PSINet	(800) 827-7482	$19.00			$6.50	all
UUNET-Canada	(416) 368-6621		$20.00		$6.00	news and e-mail

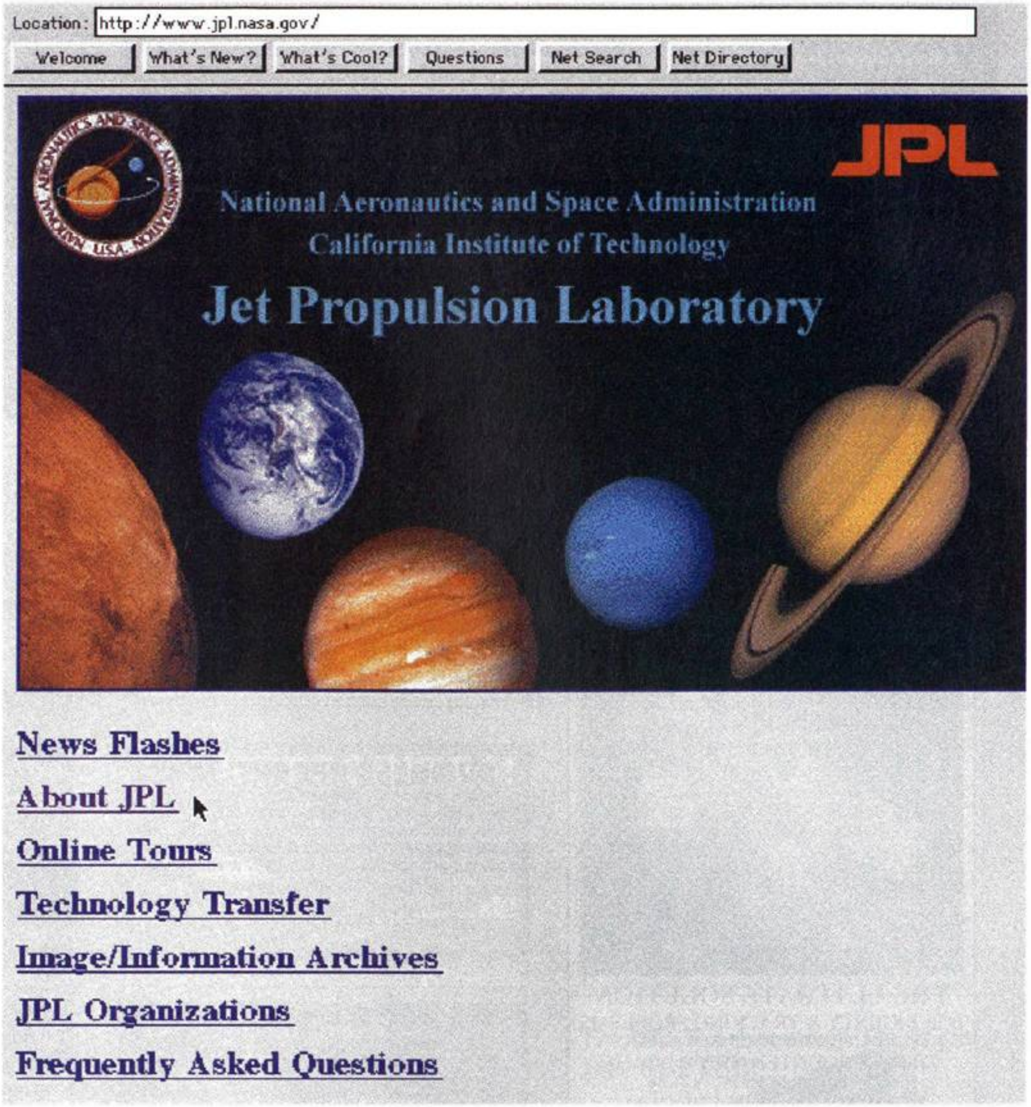
Rates can vary for each company depending upon modem rates; quotes are for 9,600 or 14,400-speed modems. Charges may accrue for long-distance phone connections. Rates are changing quickly, usually becoming cheaper. Services are for shell or on-line access to the Internet. Several of these companies also offer connections to link your computer to the Internet.

Often the registration fee also entitles you to an upgraded version of the program, a manual, or another incentive. But after the trial period, it is illegal to continue using the program without registering it. Someone worked hard to write the program so please pay the registration fee.

Lots of basic Internet programs are available as freeware so why buy software for cruising the Internet? The answer is the same as for other software packages: The shareware and commercial versions of software can do more, and with greater ease, than their free counterparts.

Spinning a Web

The Internet tools listed above are okay, but the Web is where the action's really at. Gopher, ftp, and archie are relatively primitive means for accessing the resources on computers in the Internet. You need to know what you want and have some idea of where to find it or at least how to search for it. Computer scientists have started to look at more powerful and clever ways to link information so you don't have to know key words, search through thousands of sites to find files, or remember arcane computer addresses. One of the first results is called the World Wide Web.



National Aeronautics and Space Administration
California Institute of Technology
Jet Propulsion Laboratory

News Flashes
About JPL
Online Tours
Technology Transfer
Image/Information Archives
JPL Organizations
Frequently Asked Questions

SPACE NEWS, images from spacecraft, and a tour of the solar system are a few of the resources on the home page produced by NASA's Jet Propulsion Laboratory.

The Web uses a powerful concept called hypertext to link text, images, movies, sound, or anything that can be stored as a file on a computer. For example, in a Web document about stars, the word "supernova" might be highlighted or underlined. Merely clicking on the word could bring up the latest image of Supernova 1987A or a list of recent supernovae. You remain unaware of the fact that the computer automatically retrieved the image from a Space Telescope Science Institute computer in Maryland or the list from a computer in Australia or Germany. The Web document contains the links in it so you don't have to bother with specific computer locations and addresses.

To access Web resources, you use a Web browser such as *Cello* for PCs (Cornell University; ftp to address **fatty.law.cornell.edu**), *Mosaic* for PCs and Macs (National Center for Supercomputing Applications; ftp to **ftp.ncsa.uiuc.edu**), *Netscape* for PCs and Macs (Netscape Communications; ftp to **mcom.com**, and *WinWeb* for PCs (EINet; ftp to **ftp.einet.com**).

A great place to start exploring the Web is the CERN home page. A home page is essentially a menu of Web documents. CERN, the European high-energy physics lab, developed the Web concept and has lots of links to other Web documents from its home page. To get to a Web resource using a browser, open the documents address, called a Uniform Resource Locator. The CERN home page URL is **http://info.cern.ch** (the http prefix tells the browser that it should use hypertext protocols to open the document; ftp as a prefix indicates the document is at an ftp site). Click on the highlighted words *Other catalogues* by subject and then click on *Virtual Library* when the next screen comes up. Clicking on *Astronomy and Astrophysics* opens up a listing of catalogs, databases, images, and other files of interest to astronomers. Lots of astronomy clubs are beginning to establish home pages on the Web, too.

But the documents listed in the Virtual Library are just a sampling of resources on the Internet. The table, Great Destinations, lists ftp and Web sites that astronomy enthusiasts may wish to explore. You can search for other files on the Web with a program called *Webcrawler* or through indices such as Yahoo.

Most users will probably agree that the real problem isn't finding material, it's having enough time to look at everything and to try out all the nifty programs. The great resources on the Internet will undoubtedly change how astronomy hobbyists view their pastime by changing how they build observing lists, learn about new events, discover new ideas, look at images, or communicate with one another.

See you on the Web! □

ASTRONOMY'S MARKETPLACE

Welcome to the MARKETPLACE section in ASTRONOMY Magazine. These pages are specifically designed to be an affordable and highly effective way for you to market astronomy-related products or services.
Call **Debbi Simon** at **800-558-1544, ext. 636** to place your advertising message here.

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PO Box 49446, Colorado Springs, CO 80949-9446

JSL

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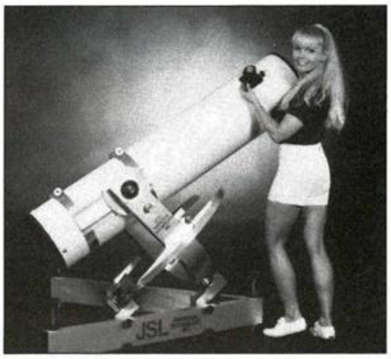

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PREMIUM NOVA OPTICS
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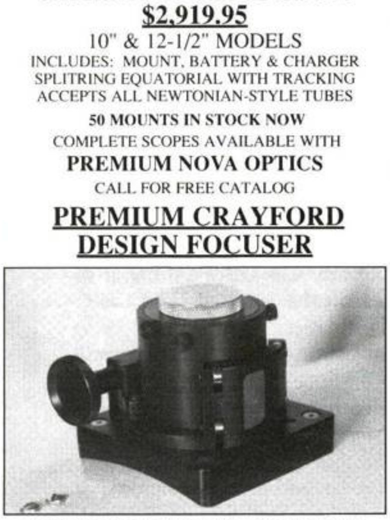
PREMIUM CRAYFORD DESIGN FOCUSER



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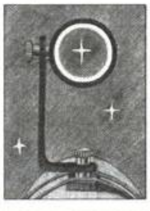

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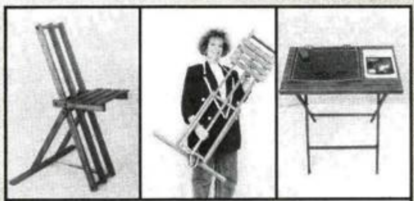

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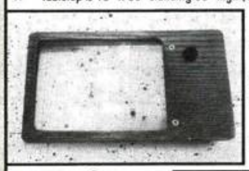

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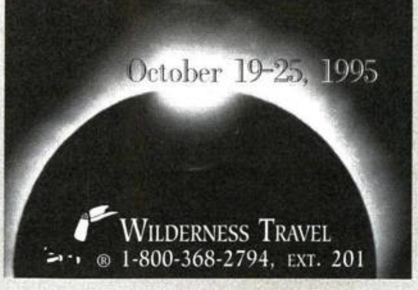

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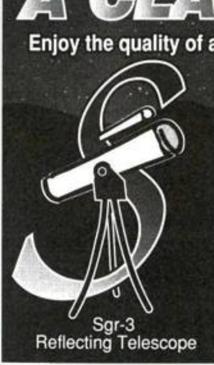

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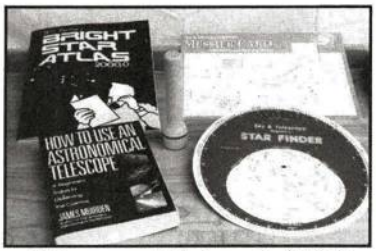

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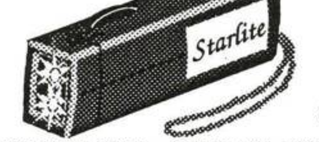

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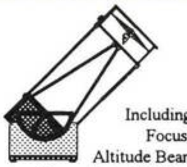

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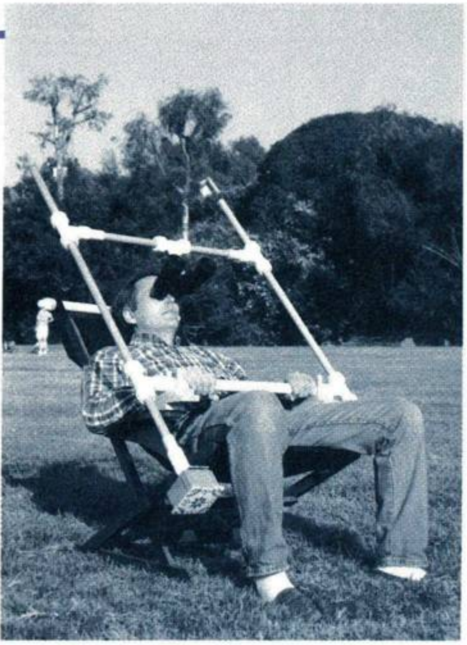

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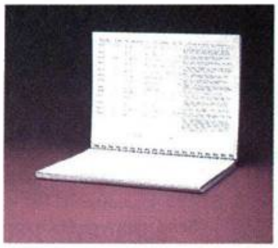

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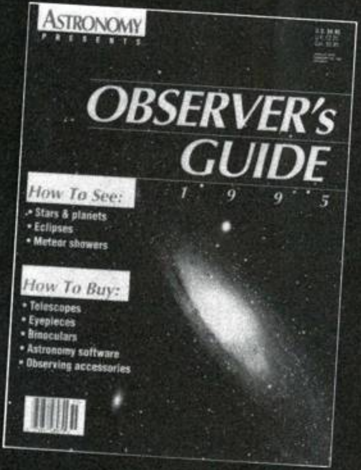

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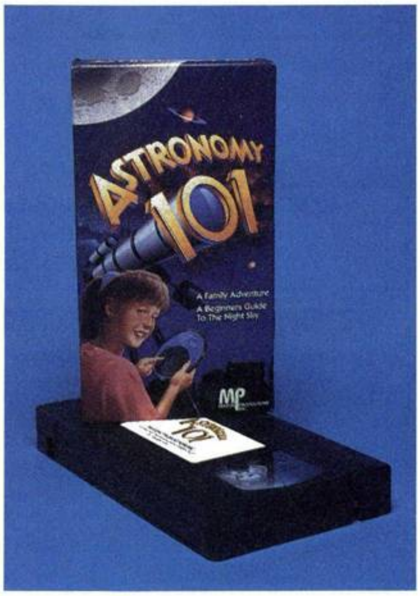

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Astronomy 101 follows a mother and daughter team as they learn about the Moon and its phases, different telescope types, what causes the seasons, and how to use a planisphere. A bibliography of astronomy books follows this overview. The tape lasts 25 minutes and is intended for 7- to 12-year-olds.

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ASTRO BYTES

A Covey of CD-ROMs

A Brief History of Time by Stephen Hawking

The immense storage capability of CD-ROMs has lots of applications in astronomy. A CD-ROM can hold hundreds of images of planets and galaxies for use in image-processing programs or in newsletters. The disk can also hold the multitude of images that make up a movie. Or it can store the programs, images, and audio and video clips needed for a multimedia presentation.

This roundup of CD-ROMs contains examples of all three types. For a multimedia experience try Stephen Hawking's *Brief History of Time*. Hawking's best-selling book was widely unread by millions who found the thin book tough-going. This CD-ROM version makes the difficult a bit easier, using animations to demonstrate the book's concepts.

Viewers can explore the book a chapter at a time, either in text form or in a narrated version (using Hawking's computer-synthesized voice). Or they can explore pieces of the book and its accompanying animations such as "Relativity Street," "Quarkland," and "A Journey to a Black Hole." Clicking on objects in Hawking's "office," such as a picture of Galileo, also activates parts of the multimedia presentation.

If you really wanted to know what *A Brief History of Time* was about but couldn't get past page ten, try this version from Scientific American (415 Madison Avenue, New York, NY 10017-1111). At a minimum, it requires either a Macintosh LCII with a color monitor, 8 MB of memory, System 7.0, and a double-speed CD-ROM drive, or an 80386SX-based computer with a VGA display, 8 MB of memory, Windows 3.1, an audio card, a mouse, and a double-speed CD-ROM drive.

One of the image-rich disks is *Comet Collision with Jupiter*. It contains more than 300 images and 16 animations of the crash of Comet Shoemaker-Levy 9 into Jupiter. This disk runs on PCs or Macs and costs $19.95 plus $3 for shipping and handling. Contact Geppetto and Son, 800 Martin Street, Longmont, CO 80501, (303) 440-9140, fax (303) 651-1964. They are now working on a second disk, *The Moon CD-ROM*.

Space fans should check out the *Shuttle Encyclopedia*. This $39.95 disk contains over 3,000 GIF-formatted

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images plus almost 4,000 text files summarizing every shuttle mission. It is by Walnut Creek CDROM, 4041 Pike Lane, Suite D-893, Concord, CA 94520, (800) 786-9907, fax (510) 674-0821.

Space by Seattle Support Group has over a dozen shots of the planets and another 180 images of the space shuttle, astronauts in space, Earth as viewed from space, shuttle launches, and satellites deployed by the shuttle. The disk includes an *Adobe PhotoShop* try-out program and *Kudo Image Browser* to view the images, which are in PICT, BMP, and JPEG file formats. Seattle Support Group is at 20420 84th Avenue South, Kent, WA 98032.

Nighttime shuttle launch from *Space*

WeMake CDs offers *Reaching the Stars and Beyond: Images of NASA*, a collection of 375 images in BMP, GIF, and PCX file formats, for $30. The disk includes several PC-based viewing programs for studying the images from the Apollo, Gemini, Infrared Astronomical Satellite, Magellan, Mariner, Ranger, Voyager, and Viking missions. Subjects include Earth, Venus, the Moon, Mars, Jupiter, Saturn, Uranus, Neptune, and Comet Halley.

The same company also has four movies on CD-ROM: *The Four Days of Gemini 4, New View of Space, Apollo 8: Go for Trans-Lunar Insertion,* and *Mars: The Search Begins.* These $30 disks require an IBM PC-compatible computer, a double-speed CD-ROM drive, Windows, and an audio card. Contact WeMake CDs at P.O. Box 20158, Indianapolis, IN 46220. □

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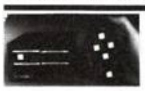

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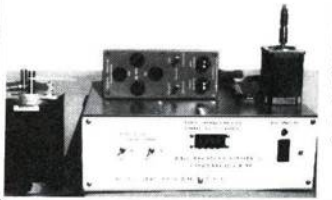

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ASTRO BOOKS

The Carnegie Atlas of Galaxies

Allan Sandage and John Bedke (Carnegie Institution of Washington and the Flintridge Foundation, 1994), ISBN 0-87279-667-1, two volumes, 750 pages, 14 inches by 17 inches, $92 plus $4 shipping. Contact The Carnegie Institution Press, 1530 P Street, NW, Washington, DC 20005-1910.

This is the comprehensive galaxy atlas Edwin Hubble dreamed of completing before his death in 1953. Allan Sandage and darkroom wizard John Bedke finished this atlas just in time, before the demise of the photographic plate. It will almost certainly be the last major photographic atlas of large-scale astronomical images to be published.

ASTRONOMY: Jim Forbes

Created with the best that darkroom and printing press (300 line/inch halftones, 100 lb. paper stock) technology can provide, the results are simply stunning. Design and production was undertaken with obvious great care. The 1,200 photographs in these volumes show that nothing matches the pure aesthetic satisfaction of conventional photography. Where CCD pictures often appear pixelated, the mature technology of photography, as seen in this atlas, is luscious.

Atlas' first three chapters deal with the typing of galaxies, and is best described as "Zen and the art of galaxy classification." Chapters one and two concentrate on the nature of scientific classification and reveal how scientists approach their subject. Sandage not only explains the traditional approach of deductive and inductive reasoning that derived from Greek and renaissance philosophy, but also explores the less strictly rational approach of raw intuition, which comes from complete immersion in the data for long periods. All three approaches are valid, and Sandage gives examples of the value of classification from biology, chemistry, physics, and astronomy. Chapter three extends this discussion into the well-known Hubble classification system in its final form.

But galaxy photos take up the bulk of both volumes, arranged by type, from pure elliptical galaxies to the most diaphanous irregulars. For people stuck on right ascension sequencing, there is an index arranged by NGC number to facilitate finding the photo of a particular object. Purists will notice that neither image scales nor orientations are given anywhere in the volumes; perhaps these can be supplied in the index of a second printing. Similarly, the photos are an inexplicable mix of positive and negative images. Being a deep-sky observer, I prefer to see only negatives (white sky background), with positives reserved for special cases. But this is a minor quibble; they all look great.

Although the pictures attract the eye, the book's real heart is a running commentary on the photographs, which appears on pages facing each panel of plates. Nearly every image has one or two paragraphs of description, often cross-referenced to pictures elsewhere in the book. This narrative contains compelling detail about the peculiarities of each galaxy and offers fascinating perspectives on the range of galactic form.

Considering its specialized nature, the price of this atlas is very low: $96 postpaid. This is made possible by a subsidy from the Flintridge Foundation that defrays printing costs. For the price of a premium eyepiece, you can own the culmination of work started in 1909 with the commissioning of the Mount Wilson 1.5-m telescope. *The Carnegie Atlas of the Galaxies* is a treat; eat it up!
— Brian Skiff

More New Books

Hazards Due to Comets & Asteroids

Tom Gehrels, editor, (The University of Arizona Press, 1994), ISBN 0-8165-1505-0, 1,300 pages, clothbound, $75.

Comet Shoemaker-Levy 9 and the Chicxulub Crater in Mexico have brought home the cold reality that human civilization is hardly immune from cosmic catastrophe. To evaluate the threat posed by comets and meteors, Tom Gehrels (a University of Arizona planetary scientist) collected 47 technical papers from 120 scientists into this comprehensive volume.

The book is divided into eight sections, each dealing with a different aspect of the threat. Papers in one section discuss how to find potentially dangerous bodies, while those in another grapple with terrestrial effects of an impact such as monstrous tsunamis, nuclear winter, and mass extinction. The longest and perhaps most speculative section suggests defensive measures that could be deployed should a large object be found on a collision course with Earth. Some of the outlined strategies require only existing technologies such as nuclear explosives and chemical rocket propulsion. Others rely on technologies that will likely be developed in the near future: solar sails, nuclear propulsion, mass drivers, and high-powered pulsed lasers.

The Cambridge Guide to the Constellations

Michael E. Bakich, (Cambridge University Press, 1995), ISBN 0-521-46520-6, 320 pages, hardcover, $49.95; softcover, $19.95.

Amateur and professional astronomers certainly do not lack choices when it comes to purchasing a star or constellation guide. Yet this new volume by Michael E. Bakich of Kansas City Museum Planetarium distinguishes itself from the competition by combining almost all the pertinent information about the 88 constellations into one volume.

This guide provides a list of information for each constellation such as the meaning of the name, a guide to pronunciation, sky coordinates, a table of Messier deep-sky objects, meteor showers, named stars, nearby stars, dates of visibility from both hemispheres, number of visible stars, and so on. A map with stars brighter than about magnitude 5 accompanies each entry. The guide also includes a most delightful feature: tidbits of information for each constellation. For example, two of the three planets discovered since antiquity, Uranus and Pluto, were spotted in Gemini. The book's major shortcoming is the lack of deep-sky objects in the maps. This guide is perfect for naked-eye observers, but deep-sky observers will be better served elsewhere. □

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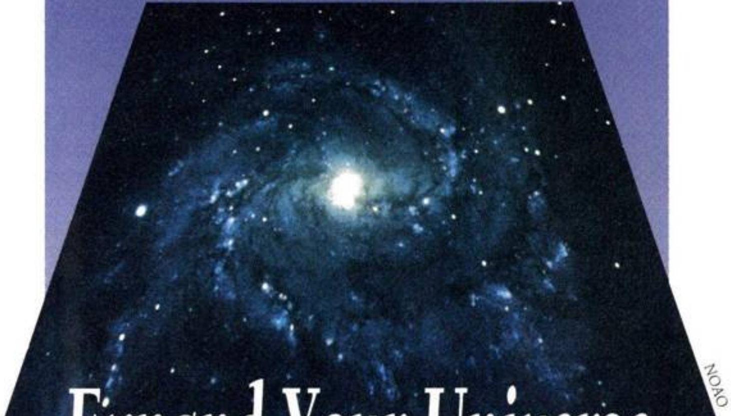

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MEETINGS & EVENTS

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ASTROGANZA 95, East Lansing, Michigan. Sponsored by the Capitol Area Astronomy Club. Contact Kurt Melvin, Abrams Planetarium, MSU, East Lansing, MI 48824, (810) 229-4391.

May 20
The Webb Society Annual Meeting, Cambridge, United Kingdom. Sponsored by The Webb Society. Contact Brian McInnery, 14 Heathfield Avenue, Poole, Dorset, England BH12 5DJ.

May 27-30
South Pacific Star Party, Ilford, New South Wales, Australia. Sponsored by the Astronomical Society of N.S.W., Inc. Contact Tony Buckley, P.O. Box 208 Eastwood, N.S.W. 2110, Australia, 61-2-337-3371 or fax 61-2-337-3378.

June 2-3
Astronomy Festival of Red Rock State Park, Sedona, Arizona. Sponsored by the Sirius Lookers of Sedona and Verde Valley Astronomy Club. Contact Russell A. Nidey, 1101 Zalesky Road, Cottonwood, AZ 86326, (520) 634-7332.

June 2-4
WOW '95, Waupaca, Wisconsin. Sponsored by the Northeast Wisconsin Stargazers. Contact Don Wyman, 1065 Laager Lane, Oshkosh, WI 54901, (414) 233-3083.

June 7-August 30
Naperville Astronomical Association Summer Observing Sessions, Naperville, Illinois. The club will run its 10" telescope nightly at 7:30 p.m., if the sky is clear or partly cloudy. Call if questionable. Contact George Simon, (708) 983-5029 or John Lehuta, (708) 257-0508 after 5 p.m.

June 17-24
Grand Canyon Star Party, Yavapai Point, Grand Canyon National Park, Arizona. Sponsored by the Tucson Amateur Astronomy Association. Contact Dean Ketelsen, 1122 East Greenlee Place, Tucson, AZ 85719, (602) 293-2855, ketelsen@as.arizona.edu.

June 22-28
Mid-Atlantic Star Party, west of Carthage and south of Robbins, North Carolina. Contact the Mid-Atlantic Star Party Coordinator, Occoneechee Council BSA, P.O. Box 41229, Raleigh, NC 27629, (919) 362-5194.

June 22-23
Universe in the Classroom, College Park, Maryland. A workshop for teachers of grades 3-12. Contact the Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112, (415) 337-1100 or fax (415) 337-5205.

June 23-24
Convention of the North Central Region of the Astronomical League, Moorhead, Minnesota. Sponsored by the Fargo-Moorhead Astronomy Club. Contact Registrar, Fargo-Moorhead Astronomy Club, Moorhead State University, Moorhead, MN 56563.

June 23-25
Mason-Dixon Star Party, near York, Pennsylvania. Sponsored by the York County Parks Astronomical Society. Contact Todd Ullery, R.D. #1 Box 5AA, Glen Rock, PA 17327, (717) 235-1153.

June 23-25
Fieldstar 95, Vernonia, Oregon. Sponsored by the Northwest Astronomy Group. Contact Sandy Mikalow, Vernonia Peak Observatory, 55371 McDonald Road, Vernonia, OR 97064, (503) 429-2430.

June 23-25
Mid-States Region of the Astronomical League 1995 Convention, Conway, Arkansas. Sponsored by the Central Arkansas Astronomical Society. Contact Chris Lasley, MSRAL 95, P.O. Box 1615, Conway, AR 72033.

June 24-25
Universe '95, College Park, Maryland. Contact Universe 95, Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112, (415) 337-1100 or fax (415) 337-5205.

June 29-July 2
RASC General Assembly, Windsor, Ontario. Sponsored by The Royal Astronomical Society of Canada. Contact Frank J. Shepley, 344 South Middle Road, R.R. #2, Maidstone, Ontario NOR 1KO, (519) 723-2389 or e-mail, sheple6@server.uwindsor.ca. □

Submit announcements to ASTRONOMY Meetings and Events, P.O. Box 1612 Waukesha, WI 53187-1612, or on the Internet, use 72000.2704@CompuServe.com. Submissions must be received at least four months before the event.

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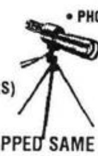

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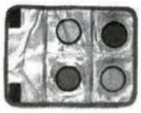

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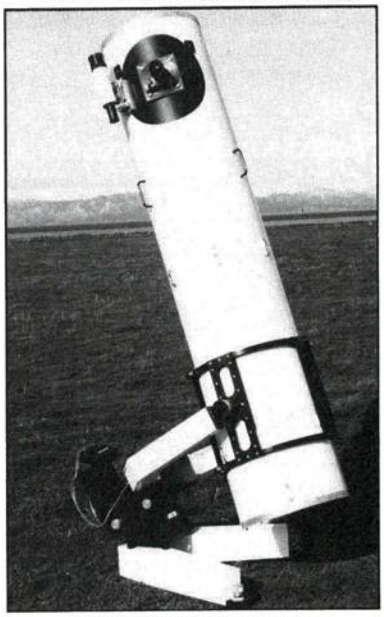

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Fab Four (page 30)

Asteroids II, edited by Richard P. Binzel, Tom Gehrels, and Mildred Shapley Matthews, (University of Arizona Press, 1989). The definitive scientific work dealing with the study of asteroids.

Moons and Planets, by William K. Hartmann, (Wadsworth, 1993). Now in its third edition, this is the best introduction to planetary science available. It covers a lot of basic information about asteroids.

A Galaxy of News (page 40)

"How Far to Virgo?" by Ken Croswell, ASTRONOMY, March 1995. About the first measurements of distances to Virgo Cluster galaxies using Cepheid variable stars.

"Candles to Light the Night," by David J. Eicher, ASTRONOMY, September 1994. A descriptive overview of the distance scale controversy and the various methods of measuring distances in the universe.

Lonely Hearts of the Cosmos, by Dennis Overbye, (HarperCollins, 1991). A wonderful and highly readable look at the community of astronomers and cosmologists struggling to measure the size of the universe.

A Friend for Life (page 46)

"The Cosmic Origins of Life on Earth," by Christopher Chyba, ASTRONOMY, November 1992. Explores the possibility that comets and asteroids seeded Earth with organic matter, and suggests that life may have sprouted many times before gaining a foothold.

Deep Sky on Four a Day (page 64)

Observe the Herschel Objects, by the Ancient City Astronomy Club, (The Astronomical League, 1980). A guide to 400 of the best Herschel objects, arranged by season. Available from Astronomical League Sales, 1901 South 10th Street, Burlington, IA 52601. $6.

Observing Handbook of Deep-Sky Objects, by Christian B. Luginbuhl and Brian A. Skiff, (Cambridge University Press, 1990). Extensive observation notes outline hundreds of deep-sky objects.

The Observer's Sky Atlas, by Erich Karkoschka, (Springer-Verlag, 1990). A handy pocket-sized book with close-up charts for deep-sky objects.

Stars and Galaxies: ASTRONOMY'S Guide to Exploring the Cosmos, edited by David J. Eicher, (Kalmbach, 1992). A compilation of deep-sky observing articles from ASTRONOMY that presents some information on Herschel objects.

Saturn's Rings (page 70)

The Saturn Handbook, (Association of Lunar and Planetary Observers). Provides a full description on how to observe Saturn, its rings, and its satellites.

The Sky: A User's Guide, by David H. Levy, (Cambridge University Press, 1991). A general guide to getting started in astronomy. Devotes a large section to the planets, including how to observe Saturn and its rings and moons.

Infobahn (page 74)

The Whole Internet, by Ed Krol, (O'Reilly and Associates, 1994). Discusses how to get connected and how to use Internet tools including Web browsers. Also lists Internet providers and places to visit.

The Internet Guide for New Users, by Daniel P. Dern, (McGraw-Hill, 1994). Describes how to use ftp, archie, gopher, and other Internet tools.

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p. 59: Donald C. Parker, August 15, 1984; **p. 62:** Hal Jandorf, 135mm lens at f/2.8, GAF 200 film, 10-minute exposure on August 28, 1976; **p. 66:** Tom Polakis, Saturn in Scorpius; 50mm lens at f/2, 15 seconds, Ektachrome 400 ; **p. 67:** Tom Polakis, 35mm lens at f/2.5, one hour, Ektachrome 400 ; **p. 68:** Tom Polakis, 50mm lens at f/5.6, 15 seconds, Ektachrome 400; **p. 72:** all photos by Charles Capen, 24-inch Cassegrain; **p. 73:** Edward Emerson Barnard; **p. 105, top:** David A. Fabrizio, 3-inch refractor at f/23, Ektachrome 1600 film, 1/4-second exposure on January 27, 1995, from Naugatuck, Connecticut; **bottom:** Jorge Ivan Cerritos, 2.5-inch refractor, sketched at 4:36 a.m. CST (left) and 5:25 a.m. on January 23, 1995, from Winnipeg, Manitoba; **p. 106, top:** Maurice Gavin, 300mm lens at f/4, Starlight Xpress CCD camera, taken in January 1995; **middle:** Maurice Gavin, 85mm lens at f/2, Starlight Xpress CCD camera; **bottom:** Preston Scott Justis, 10-inch f/6 reflector, hypersensitized Tech Pan film, 140-minute exposure on September 11/12, 1994; **p. 107, top:** Larry Landolfi, 90mm lens, Lumiere 100 film, taken on December 30, 1994, from Liberty State Park, New Jersey; **bottom:** Luke Dodd, 105mm lens at f/4, hypersensitized Fuji 400 film, composite of two 20-minute exposures; **p. 108:** James R. Foster, 11-inch SCT at f/11, hypersensitized Fuji Super HG 400 film, composite of 103- and 60-minute exposures. ☐

ASTRONOMY'S CLASSIFIEDS

This section is open to anyone who wants to sell or buy astronomy-related merchandise. **RATES:** $1.25 per word. Mininum charge is $12.50. Prepayment required. All copy is set in standard typography. We do not furnish box numbers. **CLOSING DATE:** 5th of the month three months before the cover date (i.e., March 5th for the June issue). Send your ads to ASTRONOMY, Classifieds, 21027 Crossroads Circle, PO Box 1612, Waukesha, WI 53187. 1-800-558-1544 ext. 538. MasterCard-VISA-AmerExpress.

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Communications Wanted

Collector desires correspondence with dealers or collectors of early star charts and star atlases from 1500 to 1801. Particularly interested in work by Piccolomini, Gallucci, Bayer, Schiller, Cellarius, Hevelius, Flamsteed, Goldbach and Bode. Contact Ray Harris, 2111 Wisteria Road, Macungie, PA 18062, (610) 395–8809.

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I am interested in the mystery of the lost Chinguetti Mauritania Meteorite and would like to correspond with someone who has been to Mauritania, or has knowledge of the meteorite. Contact Lee Sawyer, HCR 62, Box 56, Mt. Desert, ME 04660.

Information on all known or suspected meteor showers with data for research purposes. Attempting to compile complete listing of above, with a view to eliminate discrepancies. Contact Don Simpson, 78 Stratford Avenue, Grangetown, Sunderland, SR2 8RZ, England, 091-567-0151.

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High quality mineral collection of 100 specimens. Current value is $2,000. Will exchange for CCD system, good 8" Meade or Celestron or sell for $1,250. Contact Dr. M. G. Weller, Pendeen, Cornwall, TR19 7EL, England.

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Expert in your field or hobby? Good storyteller? Consider becoming a columnist. Send SASE to: Expert Ink, Box 41202, Baltimore, MD 21203.

Organization Announcements

Astronomical Society of Southern New England meets every last Saturday of the month with public viewing at Carpenter Museum, Rehoboth, Massachusetts. Contact Ken Conca, (401) 351–5676.

Attention Toronto-area astronomers. An observing group is now forming in Markham, Unionville, Stouffville, Newmarket, Aurora and surrounding areas. If you are interested contact Rob Underhill, (905) 471–5996 or Peter Smirlies, (905) 895-1267.

Interested in astronomy? Live in Peru? We have an astronomy club for you! Ours meets regularly and organizes many activities. Ephemeris and events bulletin coming soon. Contact Luis Miguel, Urbina 354639 Peru; Julio Chaname, Lima 637887 Peru; or Javier Quino, Lima 361348 Peru.

Kettering and District Amateur Astronomers Society meets at 7:30 pm on the first and third Tuesday of each month at the Quaker Meeting Hall, Northall Street, Kettering, England. Correspondence invited from other societies. Contact Steve Williams, 120 Brickhill Road, Wellingborough, Northants, NN8 3JP, England.

Live in Pennsylvania? Tired of trying to see the stars through murky light pollution? If you're serious about saving the stars, please contact me. If other states can pass light pollution legislation, why can't we? Contact P. Edward Murray, 918 Hamilton Drive, Yardley, PA 19067-4302.

The Astronomical Society of Harrisburg meets at 7:30 pm on the second Monday of each month at the Naylor Observatory near Lewisberry May through September. Contact Edward L. Naylor, (717) 938-6041.

The Society for Amateur Scientists, a nonprofit organization of amateur and professional scientists, including Nobel Prize winners, dedicated to empowering people to make their own discoveries. You don't need a college degree or research experience to join, only a passion for science and a willingness to learn. Support for your own research and cutting-edge projects are now underway in astronomy and other fields. Contact us at (800) 873–8767.

The Stratford-upon-Avon Astronomical Society is a recently formed organization in the United Kingdom. We welcome visitors on a regular basis, exchanging various cultural activities. Eventually, we hope to meet our colleagues overseas. If you have an interest, drop us a line. Contact John Harrison, Secretary, Stratford-upon-Avon Astronomical Society, 14 Avon Crescent, Stratford-upon-Avon, Warwickshire, CV37 7EU, United Kingdom.

Telescopes For Sale

Custom Crayford focuser, four ball bearings, 1.25", $45.00. Mike Fallwell, 26871 Alessandro, #50, Moreno Valley, CA 92555, (909) 486–9116.

Dobsonian telescope, has 10" mirror, complete, $895.00. Information: Powers, 3020 Barrington Pl., Arlington, TX 76014, (817) 465–4000.

Meade 8" LX200, 4 mo. old, factory new, dew shield, 2 extra eye pieces, rear cell filter/ seal, original packing boxes- $2,100.00. Contact Frank (706) 745–9477.

Supply source for sets of three or four nesting, thin-walled, brass tubes with an inside diameter of 1.25" and a minimum length of three inches. Contact A. L. Ponjee, PO Box 3346, St. Augustine, FL 32085-3346.

Tube assembly only for a 6" f/10 refractor with a Jaegers objective; $1,000 or best offer. Contact Pete, (303) 680–8171.

Telescopes Wanted

Celestron C8 optical tube assembly. Will consider additional parts including fork mount, oculars, wedge, clock drive, tripod, etc. Contact Gary Grittner, Box 937, Dahlgren, VA 22448, (703) 775–2493 after 6pm.

Elementary teacher seeks telescope for starting junior astro club. Interested in donating or selling one at reduced cost? Contact Carol Cobb, Alamosa Park Elementary School, 5130 Alamosa Park Avenue, Oceanside, CA 92057.

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A classified ad in ASTRONOMY is an easy, inexpensive way to buy and sell merchandise or advertise events. Classifieds can turn a small advertising investment into a large return! Here's how to place your classified ad:

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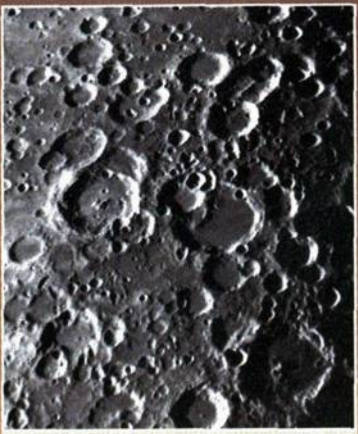

Jean Dragesco

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THE UNIVERSE OF DAVID MALIN Peerless astrophotographer David Malin brings you stunning nebulae, breathtaking galaxies, and glorious star clusters.

CRISIS IN THE DOME With money quickly drying up, astronomers face tough choices on what telescopes to keep open.

TOTALITY IN SOUTHERN ASIA The next great solar eclipse arrives in October, when the Moon's dark shadow cuts a narrow swath from Iran to Vietnam under what should be clear skies.

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Engaging the Moon

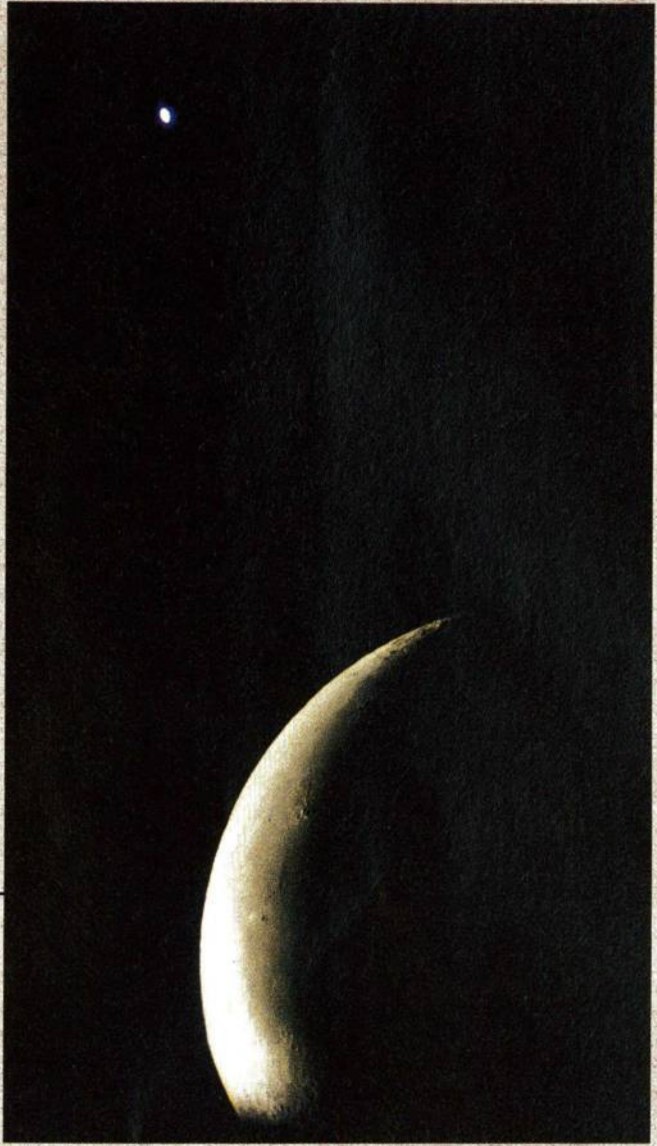
As it gracefully shifts position against its celestial backdrop, the Moon routinely inches past some bright background objects from month to month. In January 1995, however, our graceful rockball slipped by two bright astronomical bodies within four days, affording astrophotographers the opportunity to capture some beautiful shots (see "Sky Almanac," January 1995).

On the morning of the 23rd, the Moon swept past Spica, Virgo's beacon, occulting the bright star as seen by observers spread across North America (except those in Alaska and southern Canada).

Four mornings later the Moon closely encountered brilliant Venus, brightest of the stars and planets in the morning sky. At closest approach, just over 10' of sky separated the two objects.

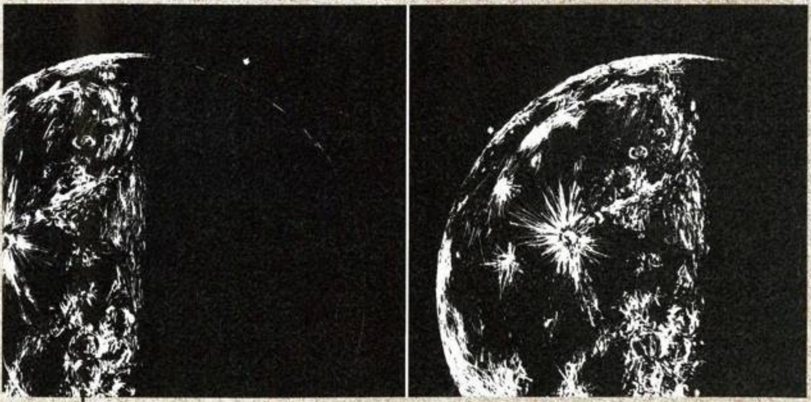
Members of the Northeast Kansas Amateur Astronomers' League ventured to dark skies outside Topeka to view the Spica occultation. "Observers were eager to glimpse Spica as it passed behind the bright lunar limb and again as it popped into view on the Moon's dark limb," says Brenda Culbertson, a league coordinator.

The clouds broke about 12:30 a.m. and allowed Culbertson, Julee Fisher, and Jerry Majers to set up their equipment: an 8-inch SCT equipped with a camcorder and VCR to record the event, a 500mm lens for conventional photography, and an 8-inch Dobsonian for pure watching. The three observers endured a –20° F



The Moon Passes Venus

by David Fabrizio
(3-inch refractor at f/23, Ektachrome 1600 film, 1/4-second exposure taken on January 27, 1995, from Naugatuck, Connecticut)



January's Lunar Occultation of Spica

by Jorge Ivan Cerritos
(2.5-inch refractor, sketched at 4:36 a.m. CST [left] and 5:25 a.m. on January 23, 1995, from Winnipeg, Manitoba)

wind chill to witness the event.

"Our adrenaline kept us warm as well as awake," says Culbertson. At 5:41 a.m. the star winked out, and all three saw the star disappear in an instant. "Spica's reappearance was not so quick," says Culbertson. "The star seemed to blossom gradually as it moved gently from behind the dark lunar limb."

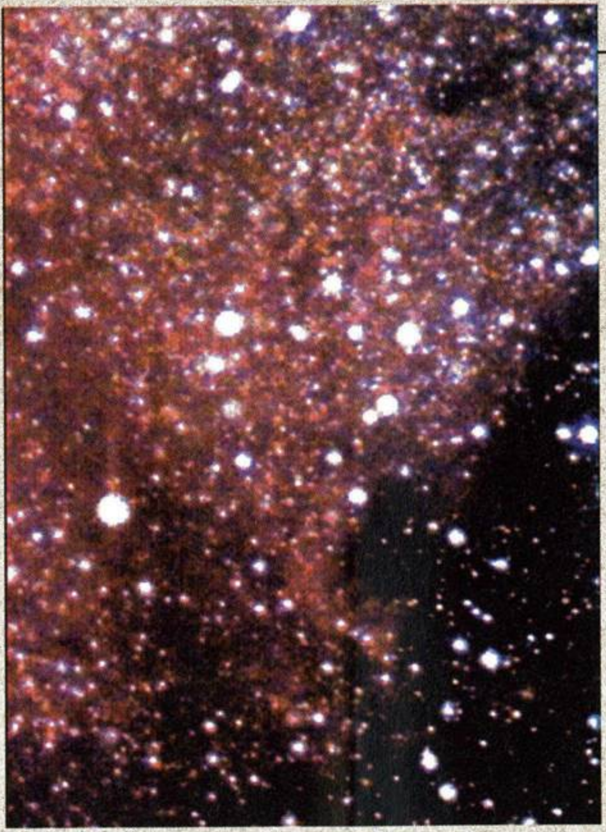
Saturn's Spokes. A group of six French and Spanish astronomers using the 1-meter telescope at Pic du Midi Observatory in the French Pyrénées reports seeing "spokes"in the rings of Saturn.

The observers recorded their finding during CCD imaging sessions on November 22 and December 16/17, 1994. "Under very stable seeing conditions we convincingly detected several spokes on the B ring, the rings being then inclined by 8° to our line of sight," the observers wrote.

Such spokes in the Saturnian rings were recorded by the Voyager spacecraft in the early 1980s and reported by a few ground-based observers since that time. Their nature is mysterious, but they may be accumulations of particles aligned by magnetic fields.

Comet P/Borrelly. Richard Didick of Rehoboth, Massachusetts, reports spotting Comet P/Borrelly (1994l) between September 3, 1994, and January 5, 1995. Didick used an 8-inch f/8 reflector at 46x to 130x. On September 3 the comet "appeared faint, showing no detail." By January 5 the comet's coma was faint but stretched east-west, and the comet's inner light was round and diffuse. "A tiny, stellar nucleus was observed," says Didick. ☐

Astronomy wants to hear about your observations. Send reports, photos, and sketches to David J. Eicher, Reader Reports Editor, Astronomy, P.O. Box 1612, Waukesha, WI 53187. Please label each item with name, address, and social security number. You may send reports via the Internet to 72000.2704@CompuServe.com.



The North America Nebula

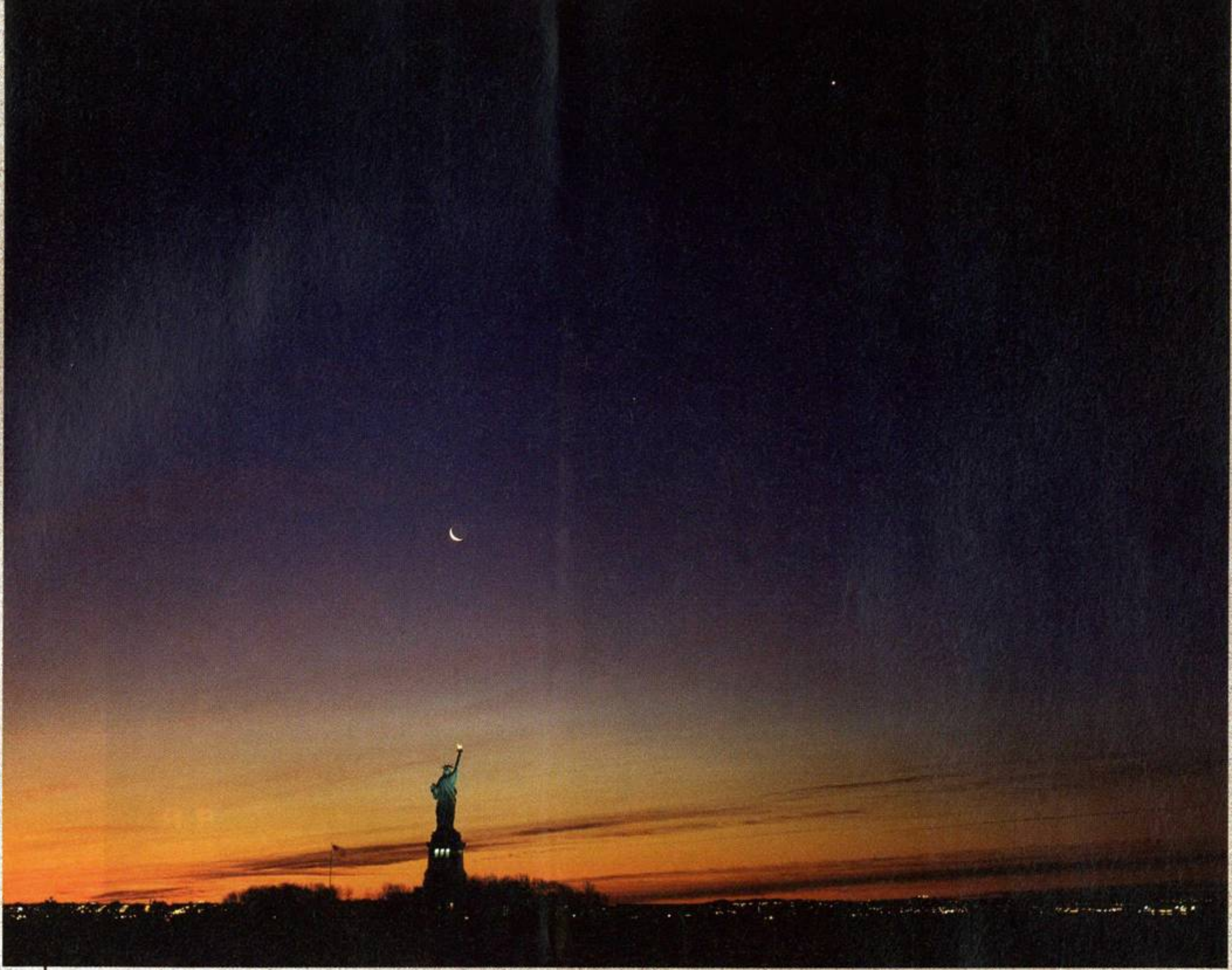
by Maurice Gavin (85mm lens at f/2, Starlight Xpress CCD camera)

Earthshine on the Moon

by Maurice Gavin (300mm lens at f/4, Starlight Xpress CCD camera, taken in January 1995)

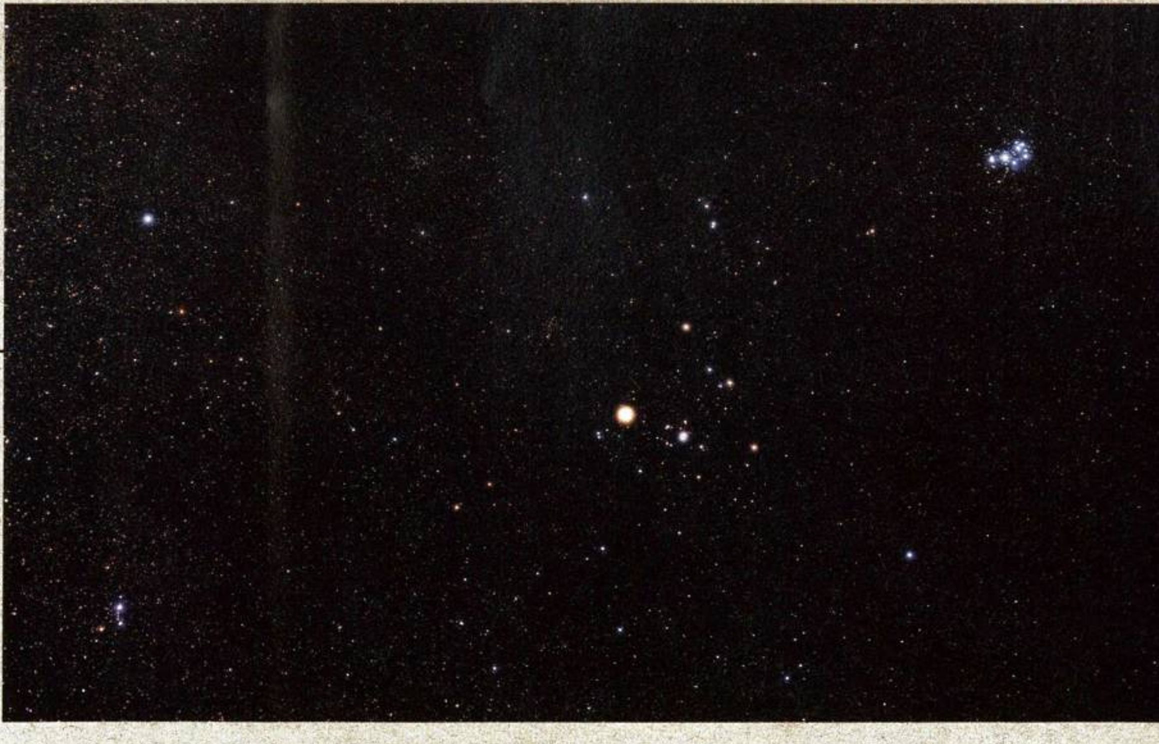
Asteroid 895 Helio Nears Galaxy NGC 205

by Preston Scott Justis (10-inch f/6 reflector, hypersensitized Tech Pan film, 140-minute exposure taken on September 11/12, 1994)



The Moon, Jupiter, Venus, and the Statue of Liberty

by Larry Landolfi
(90mm lens, Lumiere 100 film, taken on December 30, 1994, from Liberty State Park, New Jersey)



The Hyades and Pleiades Clusters in Taurus

by Luke Dodd
(105mm lens at f/4, hypersensitized Fuji 400 film, composite of two 20-minute exposures)

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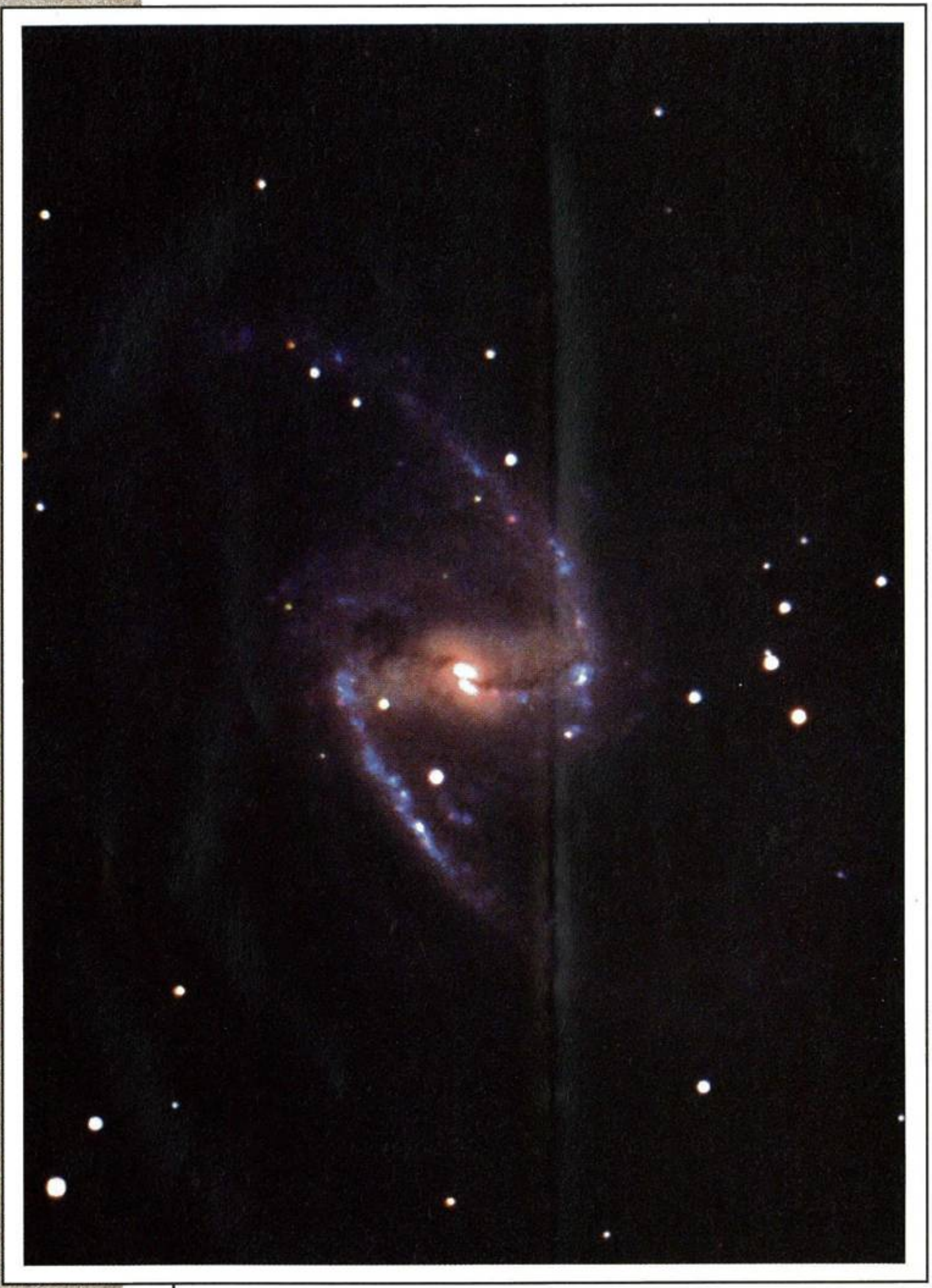

Barred Spiral Galaxy NGC 1365 in Fornax

by James R. Foster
(11-inch SCT at f/11, hypersensitized Fuji Super HG 400 film, composite of 103- and 60-minute exposures)

"I took this shot on a trip to Bolivia last November to meet some relatives and see the eclipse," says Foster. "We drove from La Paz to Huachacalla and did some deep-sky photography a couple of days before the eclipse. My list of objects was miles long and I ended up shooting things I couldn't capture as sharply at home in California because they don't rise so high in the sky.

"The galaxy's central core shows quite a bit of detail," he says. "I was so exhausted from deep-sky shooting that I took only six shots of the eclipse. But I think the trip was worth it."

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"I bought a Tectron 15" before the Winter Star Party '94 and held off upgrading my eyepieces from my home-built scope. One of your distributors set me up with your Nagler 7mm, a Panoptic 15mm and the flagship gem of all – the 35mm Panoptic.

I'm a "fun astronomer" and a wide-field freak. First light with the 35 was the late rising Lagoon nebula. I really embarrassed myself with exclamations I haven't used since adolescence like, 'holy cow!,' 'gee whiz!' and several others, not repeated here. What a view! Flatness of field to the edge; clarity and detail of nebulosity never dreamed of in my scope; separation and detail of the 'hot-star' area; and definition of the lagoon area itself.

The Nagler 7mm has shown planetary views second to none I've seen. Not only is the Martian polar cap well contrasted, the dark brown line of demarcation between polar cap and terrain is clearly defined and crisp. Pretty good for looking through two atmospheres and millions of miles.

The only drawback is that you may have wrecked my personal image. Your instruments may just have caused me to become a more serious 'fun astronomer.' Thanks for the better, cleaner, crisper...just plain great views." – Dave Gracey, FL

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The 5" f/10 Schmidt-Cassegrain telescope is a serious, high quality precision instrument made in the U.S.A. For astronomy on the go, the C5 can't be beat. Being extremely portable, it fits virtually anywhere from a compact car trunk to most airline overhead compartments. The C5 is versatile and highly expandable with numerous optional accessories. There are actually two models of the C5 – one is an AC unit (C5) and the other a DC unit (C5⁺). Otherwise, the two models are identical.

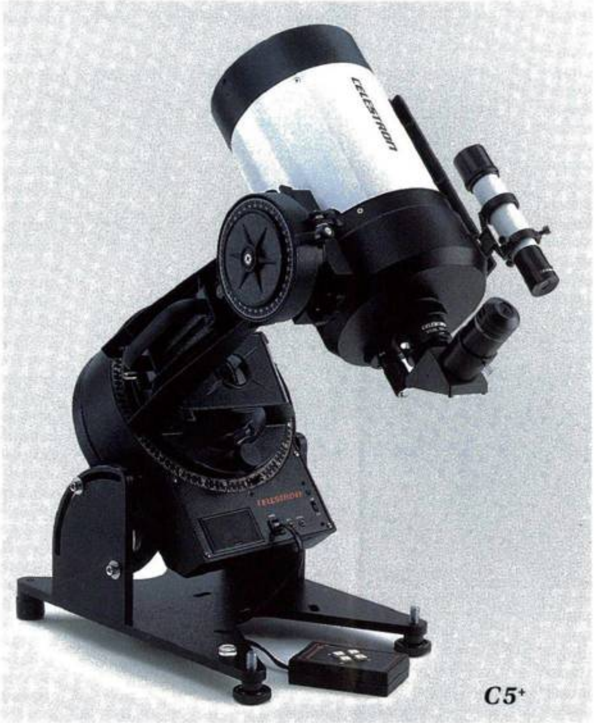
SUPERB OPTICS

Astronomy Magazine in a recent review said, "The C5 I tested contained superb optics. At high powers, stars exhibited a clearly defined Airy disk surrounded by a bright first diffraction ring and several successively fainter outer rings. This was a telescope that demonstrated how well Schmidt-Cassegrain optics can perform and met **Celestron's** promise of diffraction-limited optics."

In a recent review by *Sky & Telescope*, the following is noted, "the optical correction and factory collimation were excellent. At high magnification, bright stars were surrounded by a classic set of diffraction rings."

The C5 is truly a multipurpose instrument – an astronomical telescope, a spotting scope and a 1250mm f/10 telephoto lens. Great for terrestrial applications such as bird watching, nature study, vistas from view homes or as a superb 1250mm telephoto lens. It even focuses as close as 20'.

The C5 features Starbright® multi-coatings. Standard accessories include a 5x24 Finderscope, Star Diagonal – 1¼", Visual Back – 1¼", 25mm SMA Eyepiece – 1¼" and the equatorial wedge. Weight is 23 lbs. (including wedge).



C5⁺

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The C5 with the AC drive system is all that is needed for observational use, especially near AC power sources.

The larger light gathering power of the C5 over smaller telescopes allows observation of amazing lunar details, plus high power viewing of the planets to see detail in Jupiter's equatorial belts, the fascinating ring structure of Saturn as well as the polar caps of Mars. The C5 is large enough to observe hundreds of deep-sky objects, fully resolve many globular star clusters, and allow you to enjoy brighter nebulae, double stars and brighter galaxies.

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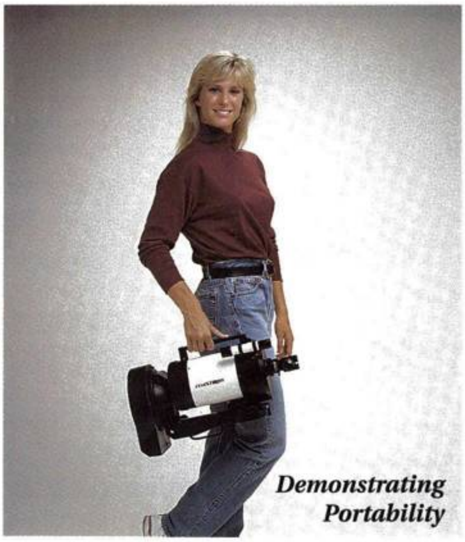
The C5⁺ is the ideal choice for astrophotography. As *Astronomy Magazine* said, "With its combination of fine optics, smooth drive system, and built-in drive corrector, the C5⁺ proved to be a good telescope for all kinds of astrophotography."



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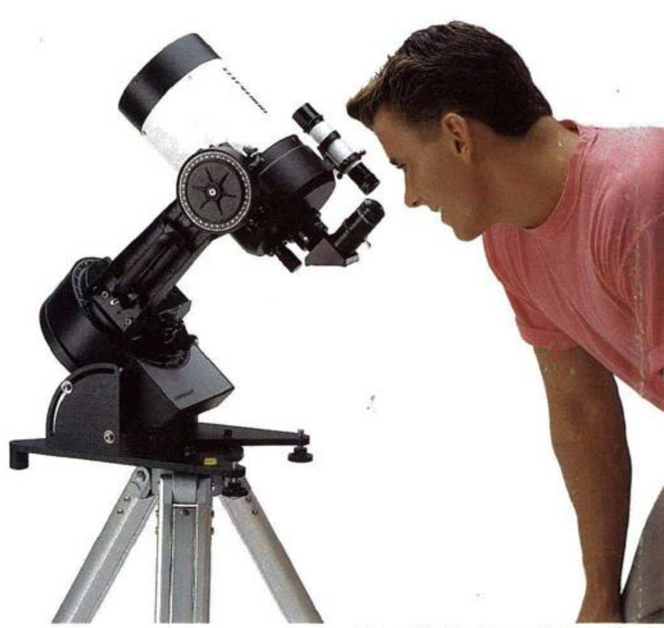

C5 with Optional Tripod

The C5 easily converts to a computerized telescope with the optional Advanced Astro Master® (AAM) This pointing system contains a data base of over 10,000 objects. The AAM operates from a single 9 volt alkaline battery for over 30 hours. It contains an RS-232 series interface.

The computer assisted telescope is fun and makes it easy to enjoy our Universe. You can find hundreds or thousands of objects easily.

For more detailed information on these telescopes, contact your Celestron dealer or Celestron.

CELESTRON® LIGHT YEARS AHEAD OF THE COMPETITION

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